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Pliensbachian (Lower Jurassic) Ammonites of the Queen Charlotte Islands, British Columbia

by

Paul L. Smith

and

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PLIENSBACHIAN (LOWER JURASSIC) AMMONITES OF THE QUEEN CHARLOTTE ISLANDS, BRITISH COLUMBIA

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ABSTRACT

The lower Maude and upper Kunga groups in the central Queen Charlotte Islands provide the most complete and fossiliferous Pliensbachian sequences in North America. Outcrops on Maude Island and at Whiteaves Bay serve as either type or reference sections for the Imlayi, Whiteavesi, Freboldi, Kunae and Carlottense zones of the standard North American zonation.

The Sandilands Formation of the Kunga Group is mostly pre-Pliensbachian in age but exposures on Kunga Island are as young as Whiteavesi Zone. The Sandilands Formation and the succeeding Ghost Creek Formation of the Maude Group were deposited in fairly deep, euxinic waters subjected to diminishing pyroclastic and volcaniclastic input, the latter by turbidity currents. Shallowing culminated in the deposition of the coarser sediments of the Fannin Formation which were laid down in higher energy, well oxygenated waters. Most of the Ghost Creek Formation is assignable to the Imlayi Zone with its upper 10 m or so as young as the Whiteavesi Zone; at one level in the Whiteavesi Bay section, it is as young as the Freboldi Zone. The Fannin Formation ranges in age from the Whiteavesi to the Carlottense zones and locally into the Toarcian.

This report is the first comprehensive, stratigraphically controlled study of the Pliensbachian ammonoids of the Queen Charlotte Islands. Seven hundred and fourteen localities have yielded at least 1600 specimens assignable to approximately 85 species representing 32 genera or sub-genera and 11 families of ammonoids. *Charlotticeras* is established as a new subgenus of *Fanninoceras* and *Pacificeras* (Repin, 1970) is recognized as a subgenus of *Lioceratoides.* The following new species are established (in alphabetical order): *Acanthopleuroceras thomsoni, Fanninoceras (Charlotticeras) carteri, F. (C.) maudense, Lioceratoides (Lioceratoides) involutum, Oistoceras compressum, Oregonites? dawsoni, Protogrammoceras (Protogrammoceras) skidegatense,* and *Reynesocoeloceras grahami.*

INTRODUCTION

The Queen Charlotte Islands, known to the native people as Haida Gwaii, form a 280 km long archipelago off the central coast of British Columbia, Canada (Text-fig. 1). The Islands are part of the Wrangell tectonostratigraphic terrane which constitutes the greater part of the Insular Belt, the region west of the Coast Plutonic Complex.

Richardson (1873) published the first geological account of the Queen Charlotte Islands but it was not until the work of Sutherland Brown (1968) that a detailed geological map was produced. A comprehensive study of the Jurassic stratigraphy published by Cameron and Tipper (1985) was followed in 1987 by a three-year multidisciplinary project under the auspices of the Geological Survey of Canada's Frontier Geoscience Program addressing the hydrocarbon potential of the Queen Charlotte basin (Woodsworth, 1991). An important focus of this multidisciplinary study, of which this report is a component, was the Lower Jurassic part of the stratigraphic column whose thermally mature, organic-rich shales form potential hydrocarbon source rocks (Vellutini and Bustin, 1991a, 1991b).

The only existing paleontological reports on the Queen Charlotte Islands containing illustrations of Pliensbachian ammonites are those of Whiteaves (1884), McLearn (1932), Frebold (1970), and Smith *et al.* (1988). Whiteaves and McLearn did not recognize the Pliensbachian age of their fossils; Frebold's report lacked stratigraphic information and, as with Smith *et al.*'s regional study, it was less than comprehensive with respect to the Queen Charlotte Islands. The need to rectify this lack of detailed biostratigraphic and systematic information concerning the Pliensbachian ammonites of the Queen Charlotte Islands can be justified on four grounds:

(i) There is no other place in North America that offers such relatively continuous stratigraphic sequences yielding well preserved and often abundant ammonites. The Queen Charlotte Islands will serve as the type area for much of the North American Lower Jurassic ammonite zonation (Smith *et al.*, 1988, 1994; Jakobs *et al.*, 1994a, 1994b; Pálfy *et al.*, 1994) and will therefore be central to precise correlations between

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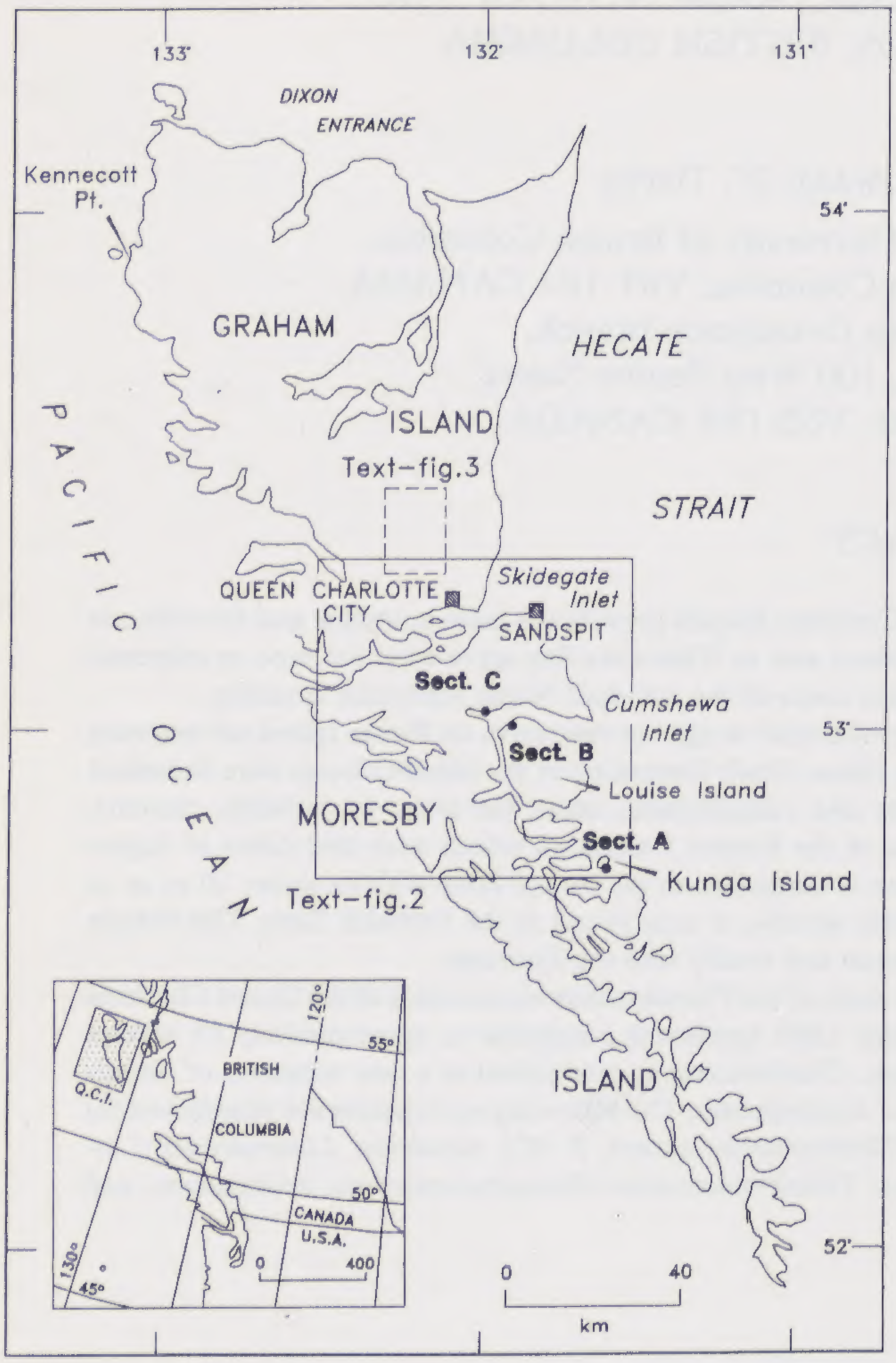

Text-figure 1.—The Queen Charlotte Islands, British Columbia, and the location of measured sections A through C.

the allochthonous terranes, as well as between the terranes and the craton.

(ii) The Queen Charlotte Islands will also be the center of a web of circum-Pacific and ultimately global correlations because of their unique biogeographic setting where Tethyan, east Pacific and scattered Boreal forms may be found in the same beds. Pliensbachian ammonite biogeography has already been used to constrain the Early Jurassic position of Wrangellia and details of ammonite paleontology are essential in assessing the relative importance of the Hispanic Corridor as a biogeographic link between the western Tethys and Pacific oceans during the Early Jurassic (Smith and Tipper, 1986; Smith, 1988; Smith and Westermann, 1990).

(iii) Lower Jurassic sequences in the Queen Charlotte Islands are yielding microfossils as well as ammonites (Carter *et al.*, 1988; Bown, 1991; Tipper *et al.*, 1991; Smith *et al.*, 1994). This offers opportunities (a) to calibrate macrofossil and microfossil zonations providing more accurate and precise correlations over a broader range of geological and sampling conditions, and (b) indirectly to correlate microfossil sequences with the northwest European standard zonation.

(iv) Because of the hydrocarbon potential of the Queen Charlotte Islands, accurate correlation of the lithostratigraphic units is important as an aid to understanding the geological and sedimentological history of the region. The fossil illustrations will also be of use to those engaged in producing more detailed geological maps.

ACKNOWLEDGMENTS

We thank the many geologists and paleontologists of the Geological Survey of Canada and the Frontier Geoscience Program who collected material and shared their stratigraphic information with us. Of particular importance have been Bruce Cameron, formerly of the Geological Survey of Canada, and Beth Carter, Giselle Jakobs, and Jozsef Pálfy, all former graduate students at the University of British Columbia.

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LITHOSTRATIGRAPHY

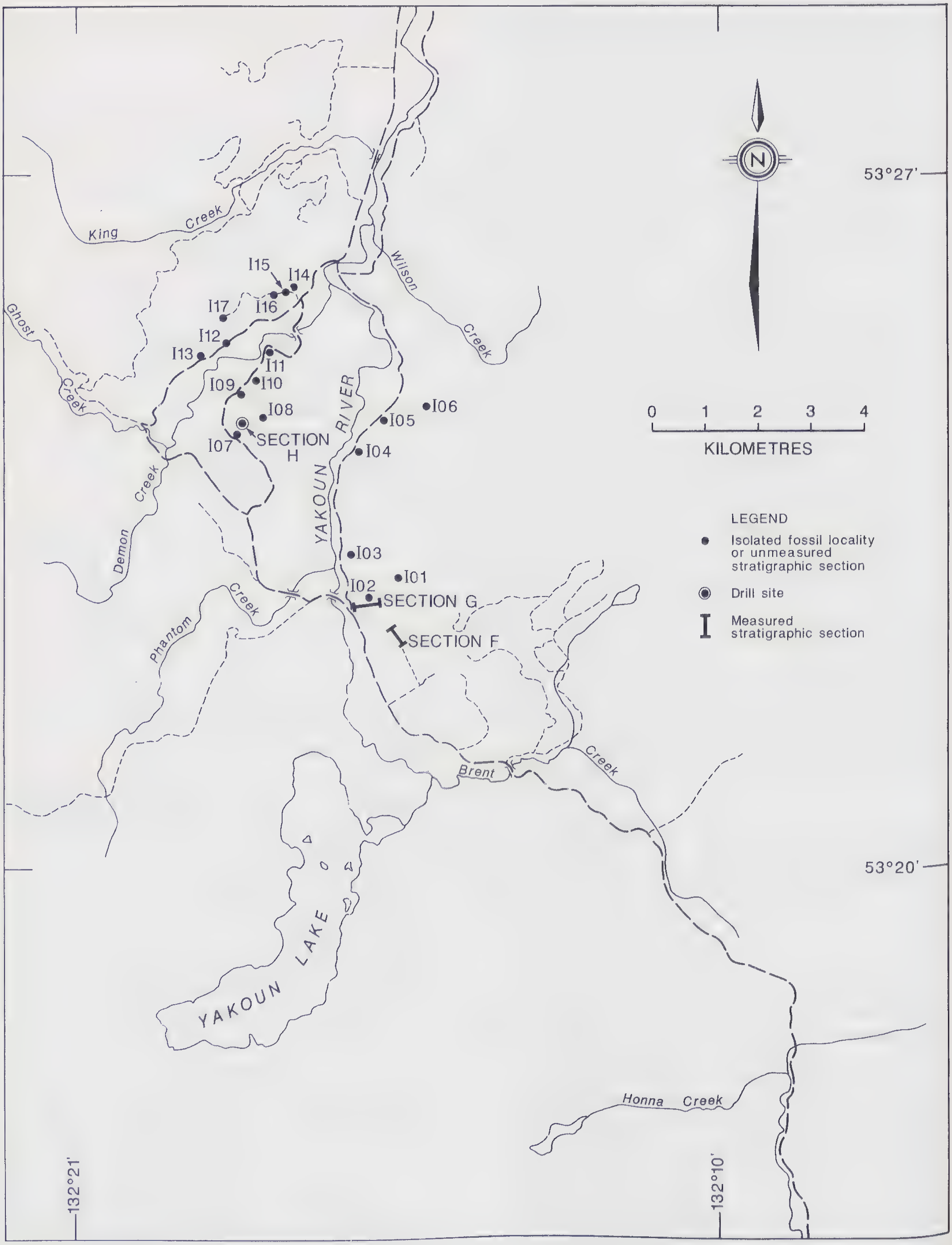
The Pliensbachian rocks of the heavily forested Queen Charlotte Islands crop out from Kunga Island in the southeast, across Louise and Moresby Islands to southern Graham Island in the northwest, a distance of approximately 90 km (Text-figs. 2 and 3). Shorelines and streams offer the best exposures but on southern Graham Island logging road cuts and road-metal quarries have increased rock exposure and improved accessibility.

Pliensbachian ammonites have been collected from the Kunga and Maude groups (Text-fig. 4) which together range in age from the Carnian to the Aalenian.

Text-figure 2.—The central Queen Charlotte Islands showing the location of measured sections A through E. See Text-figure 1.

As a result of early Middle Jurassic contractional deformation, the Maude Group is missing in some areas and the Bajocian Yakoun Group rests with marked angular unconformity on Sinemurian parts of the Kunga Group (Lewis and Ross, 1991; Thompson *et al.*, 1991). The formations of interest are the Sandilands, Ghost Creek, and Fannin formations as defined by Cameron and Tipper (1985) to which the reader should refer to supplement the brief descriptions of lithology and depositional setting given below.

The Sandilands Formation consists of several hundred meters of thinly bedded dark grey to black siltstone interbedded with graded, lithic sandstones and grey to white tuffs; volcanic breccia is present locally but bioturbation is conspicuous by its absence. Most of the unit is Sinemurian in age (Pálfy *et al.*, 1990;


53°27'
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N
0 1 2 3 4
KILOMETRES
LEGEND
Isolated fossil locality or unmeasured stratigraphic section
Drill site
Measured stratigraphic section
King Creek
Wilson Creek
Ghost Creek
Demon Creek
Phantom Creek
Brent Creek
Honna Creek
YAKOUN RIVER
YAKOUN LAKE
SECTION H
SECTION G
SECTION F
I01
I02
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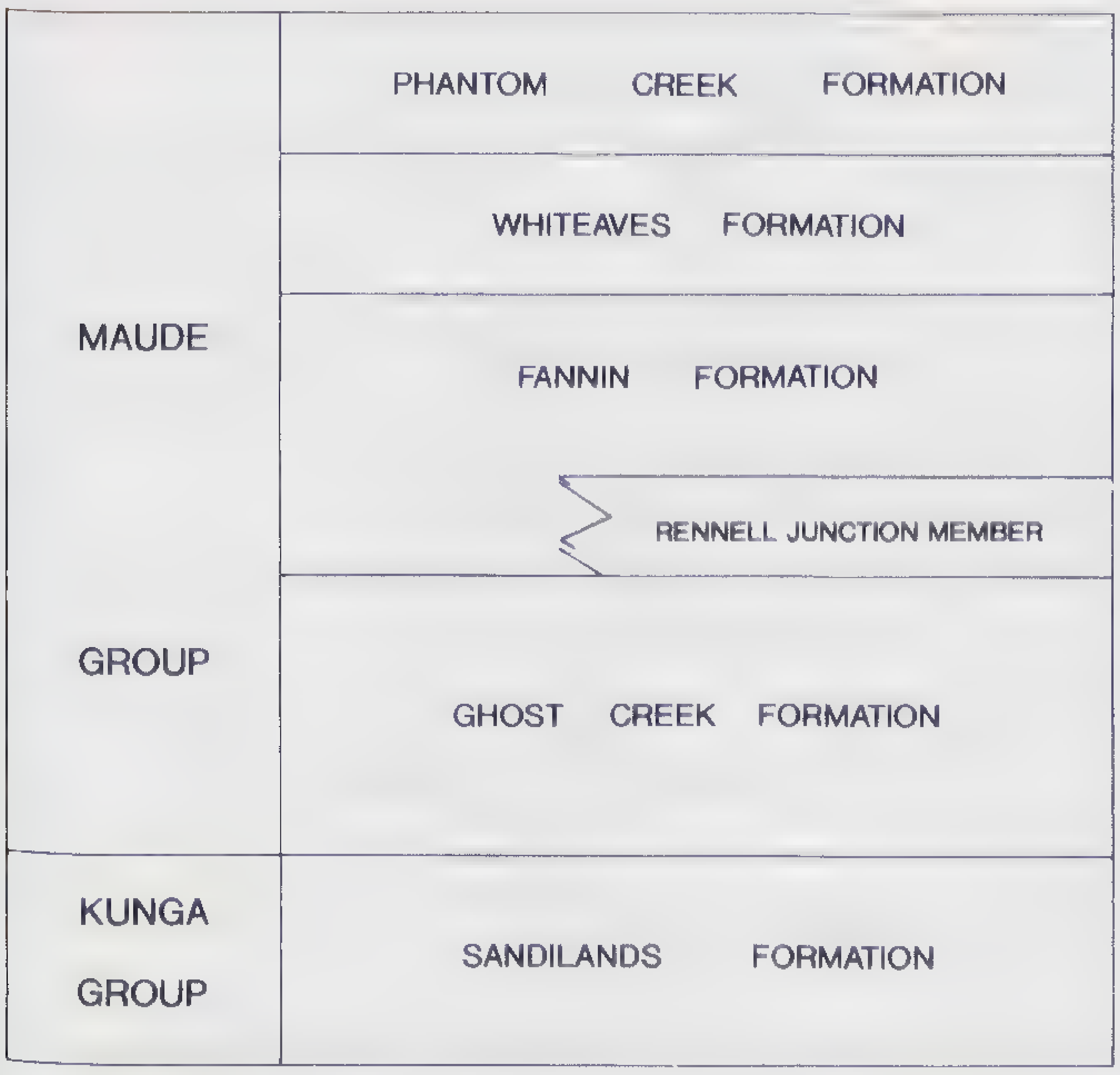
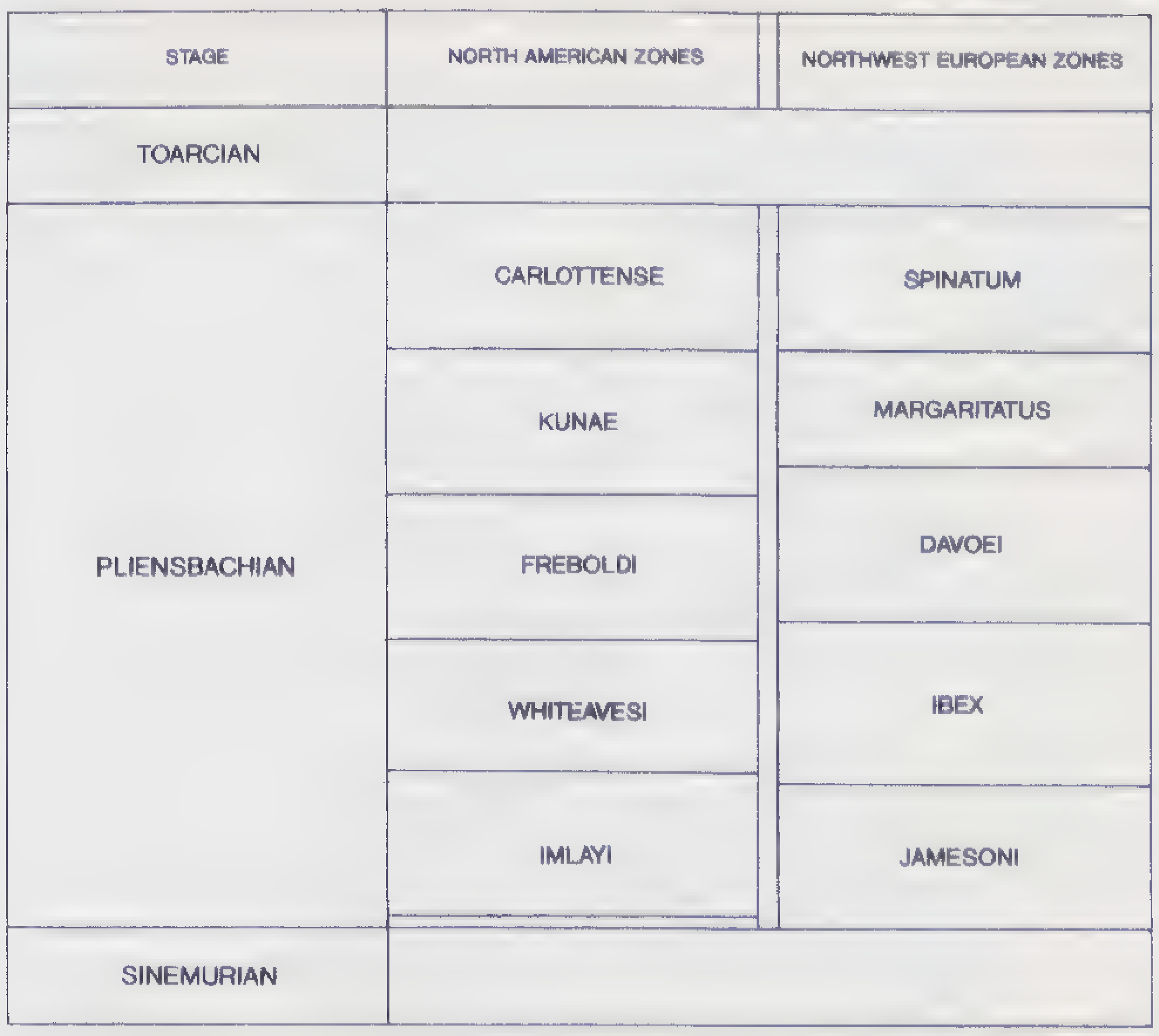


Text-figure 4.—The lithostratigraphic units of the Maude and upper Kunga groups.



Text-figure 5.—Standard Pliensbachian zones of North America utilized in this study and approximate correlation with the primary standard zonation of northwestern Europe.

Pálfy *et al.*, 1994) but the boundary between the Sandilands and Ghost Creek formations is diachronous, such that outcrops of the Sandilands in the southern part of the islands are as young as Early Pliensbachian (Pálfy *et al.*, 1990; Smith *et al.*, 1990; Tipper *et al.*, 1991). The tuff and graded lithic sandstone beds are also thicker to the south, suggesting that the Sandilands Formation was deposited in a quiet, fairly deepwater, possibly euxinic setting that was periodically subject to deposition of air-fall tuff and turbidites whose source was to the south or southwest.

The Ghost Creek Formation is a recessive unit reaching a thickness in excess of 60 m. It contrasts markedly with the underlying Sandilands Formation in having more shale and only rare ash or tuffaceous beds. The shales are dark and pyritic. Occasional sandstones and nodular limestones are present and the top of the formation becomes locally glauconitic in the north. Oil stains and bitumen are pervasive. Benthic fossils and bioturbation are not common but are more frequent in the upper part of the unit generally and throughout the unit in more southerly exposures.

The Ghost Creek Formation was deposited in fairly deep water that shallowed and perhaps became less euxinic both to the south and upsection. The setting appears to be similar to that of the Sandilands Formation except that volcanic activity had waned leading to only minor pyroclastic and coarse volcaniclastic input.

The Fannin Formation is a coarsening upward sequence that rests conformably on the Ghost Creek Formation. The transitional beds were initially named the Rennell Junction Formation by Cameron and Tipper (1985) but as the unit proved to be unmappable, it was included within a redefined Fannin Formation by Tipper *et al.* (1991) and is here referred to as the Rennell Junction Member.

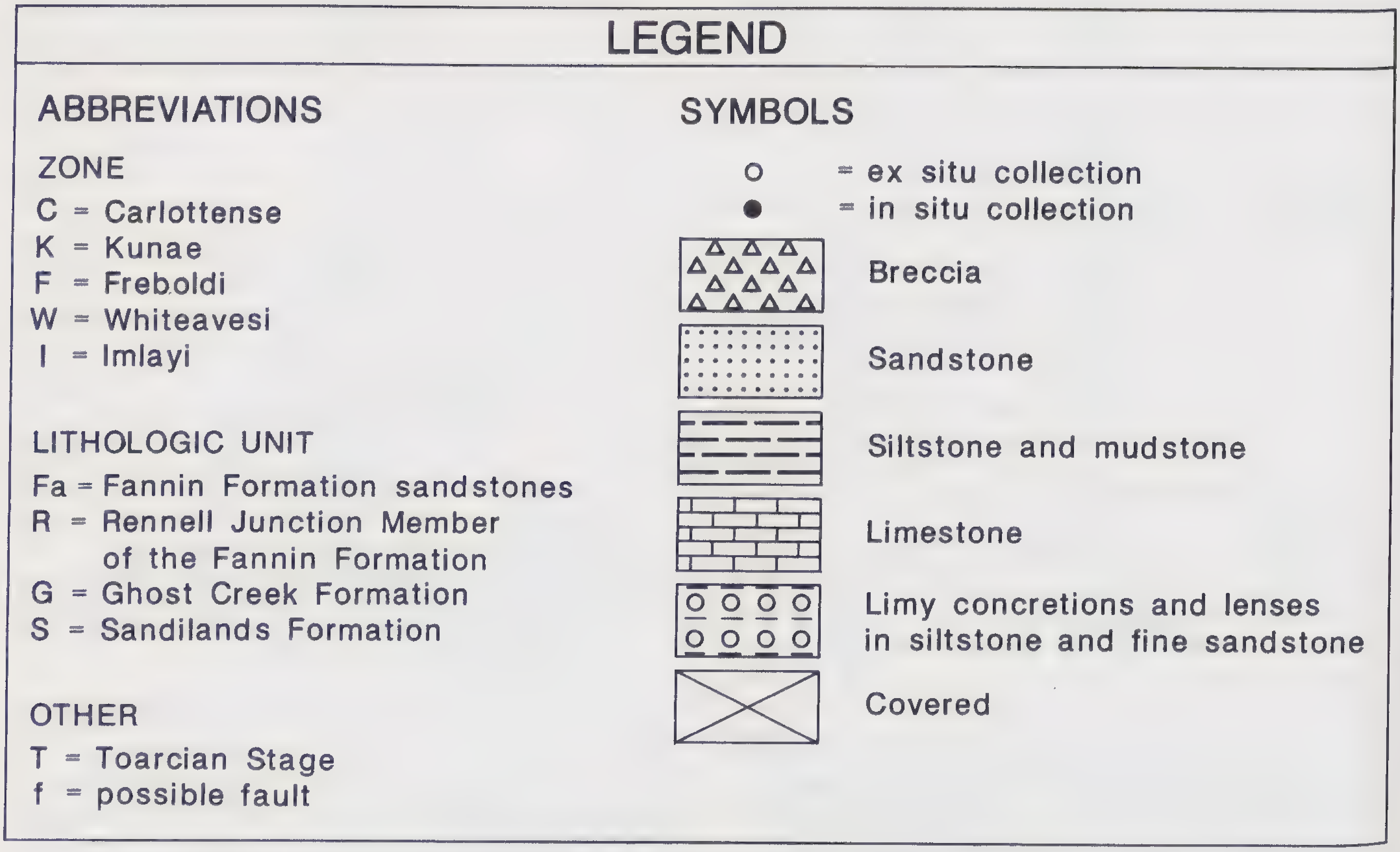
The Rennell Junction Member typically ranges in thickness from 15 to 40 m but may locally reach a thickness of up to 75 m. It consists of fine grained sandstone, siltstone, and shale with irregular limestone beds and nodules. The upper part of the Fannin Formation consists of coarser, more resistant, and thicker bedded sandstones compared with the Rennell Junction Member. This interval is fairly heterogeneous, however, and concretionary limestones, tuffs, breccias, and conglomerate lenses are locally developed. Chamosite ooliths can be abundant in the uppermost part of the unit where trace fossils, sparsely present throughout, become slightly more common.

REGIONAL SETTING AND CORRELATIONS

Zones indicated on measured sections are the North American Pliensbachian ammonite zones described by

←

Text-figure 3.—South-central Graham Island with the location of measured sections F and G; borehole H; and isolated localities I01 through I17. See Text-figure 1.



Text-figure 6.—Legend for the stratigraphic columns and faunal charts of Text-figures 7 to 14, and 16 to 24.

Smith *et al.* (1988). These zones and their approximate European correlatives are illustrated in Text-figure 5.

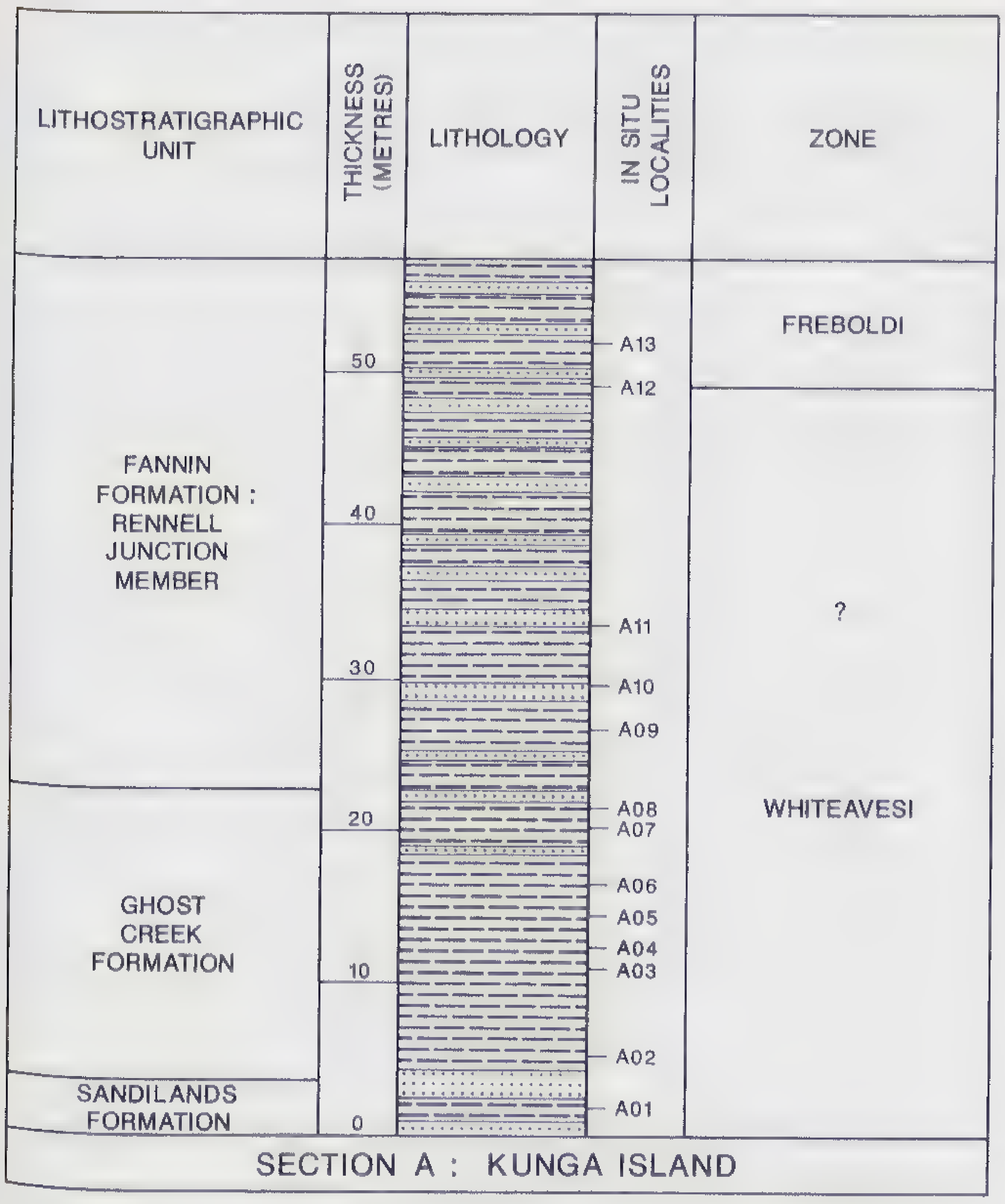
Details of lithology and lithostratigraphy for measured sections A through G and well core H are illustrated in Text-figures 6 through 14 which also show the zones present and the stratigraphic position of each fossil locality. Regional correlations are summarized in Text-figure 15.

As previously mentioned, limited exposures on Kunga Island demonstrate that a small portion of the Sandilands Formation is Pliensbachian in age. The unit is therefore at least partly coeval with the Ghost Creek and Fannin Formations. The bulk of the Ghost Creek Formation is Imlayi Zone in age but at most localities the upper part is as young as Whiteavesi Zone.

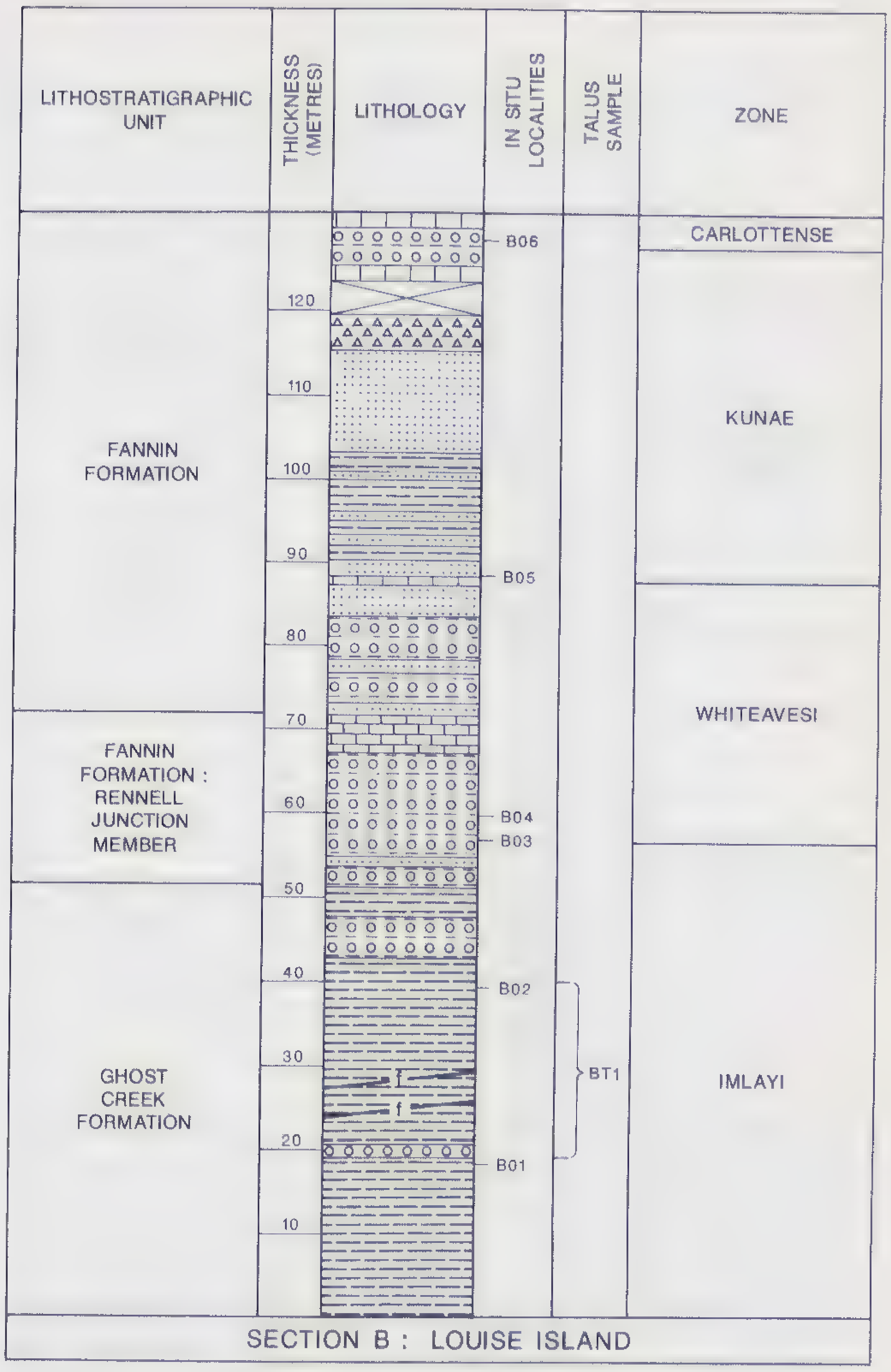
The transition from the Ghost Creek to the Fannin Formation occurs within the Whiteavesi Zone at most localities where control is good; the exception is in Whiteaves Bay (section D) where it occurs in the lowest Freboldi Zone. The transition from the Rennell Junction Member to the coarser sandstones of the upper Fannin Formation occurs near the boundary between the Freboldi and Kunae zones, usually within the Freboldi Zone. Although there is variation in the thickness of individual zones, there are no persistent lateral trends that might point to the relative proximity of sediment sources. Taken together, these observations argue for fairly uniform conditions across the sampled area during the deposition of the Ghost Creek and Fannin formations; perhaps the sections are arranged along depositional strike.

The lithologic, stratigraphic, trace fossil, and micropaleontological evidence suggests that the Pliensbachian part of the stratigraphic sequence represents a regressive event (Cameron and Tipper, 1985). The lower Ghost Creek and Sandilands formations accumulated in a stable back-arc setting in fairly deep, predominantly euxinic waters. Evidence for shallowing begins in the upper Ghost Creek Formation and culminates in the uppermost Fannin Formation where sediments were laid down in higher energy, well oxygenated waters. As has been noticed elsewhere in the world and, incidentally, in rocks of similar age, chamosite ironstones and sediments rich in chamosite ooliths characteristically occur near the top of regressive sequences. They formed in shallow seas near low lying, well vegetated land in a warm humid climate (Hallam and Bradshaw, 1979).

In summary: (i) the top of the Sandilands Formation is locally as young as the Whiteavesi Zone; (ii) the bulk



Text-figure 7.—Lithostratigraphy and fossil localities of section A, southeastern Kunga Island. See Text-figure 6 for legend and Text-figure 16 for the fauna present.



Text-figure 8.—Lithostratigraphy and fossil localities of section B, northern Louise Island. See Test-figure 6 for legend and Text-figure 17 for the fauna present. Base of section is faulted.

of the Ghost Creek Formation is assignable to the Imlayi Zone, its upper 10 m or so assignable to the Whiteavesi Zone and at one level in the Whiteaves Bay section it is as young as the Freboldi Zone; (iii) the Rennell Junction Member of the Fannin Formation predominantly ranges in age from the Whiteavesi to the Freboldi Zone; (iv) the sandstones of the upper Fannin Formation range in age from the Freboldi to the Carlottense Zone.

BIOSTRATIGRAPHY

Our approach to zonations and the naming of zones is as follows (Callomon, 1984; Smith *et al.*, 1988; Thomson and Smith, 1992; Jakobs *et al.*, 1994):

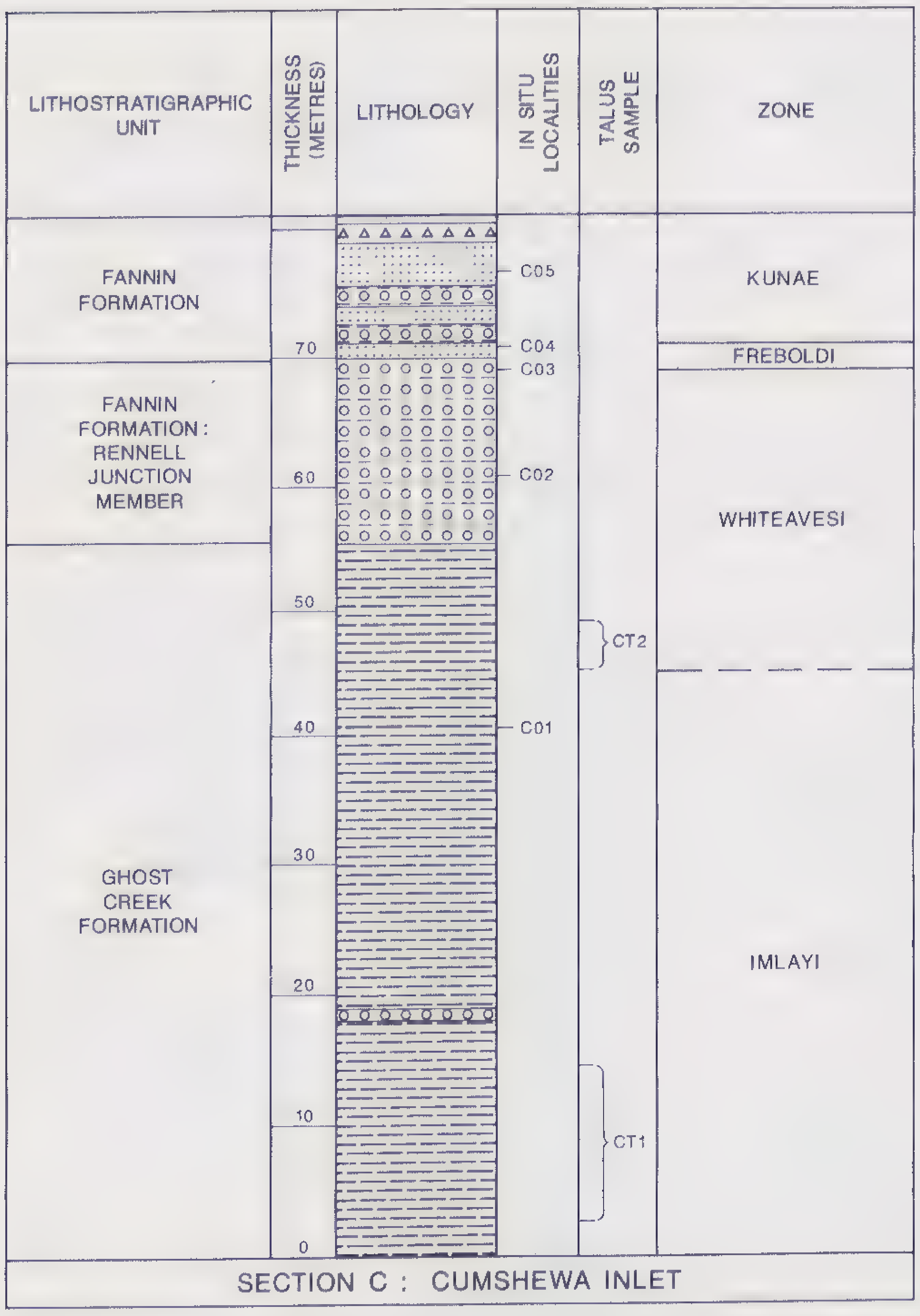
(i) No zonation can be worldwide in extent and some zonations may be restricted to a particular facies. For regionally extensive, biogeographically distinct areas, however, a standard zonation may be erected for a given group of organisms.

(ii) Standard zones are recognized on the basis of co-occurrences of species that are distinct from superjacent and subjacent assemblages. These stratigraphically distinct co-occurrences maintain their superpositional relationships throughout the geographic area in question.

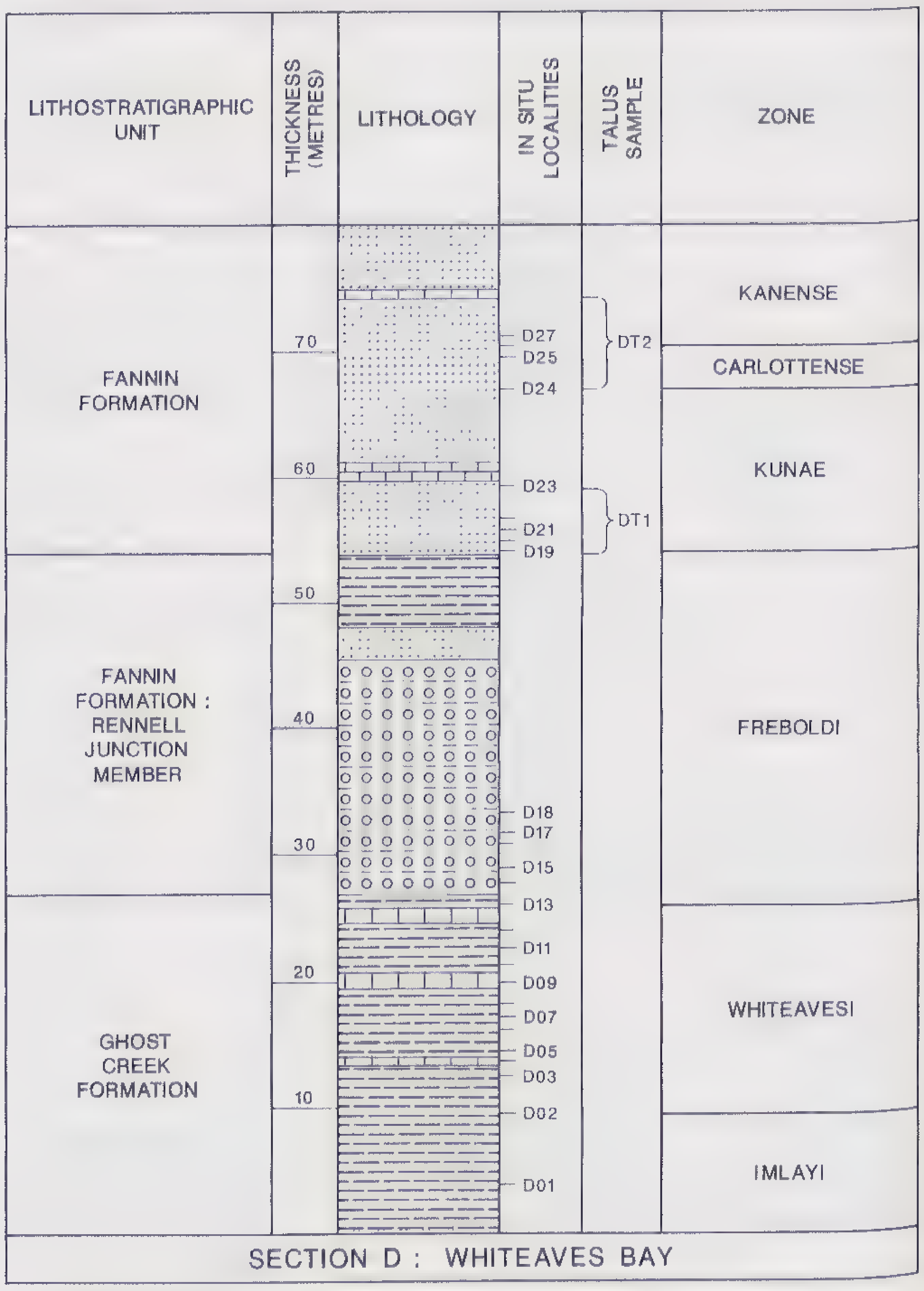
(iii) Standard zones are characterized by type sections, where the superpositional relationships are most clearly demonstrated and where zonal boundaries may be drawn. The base of a zone automatically defines the top of the subjacent zone.

(iv) By convention, standard ammonite zones are named using the non-italicized, capitalized trivial name of a species that is characteristic of that zone although not necessarily restricted to it. It is, of course, not necessary to collect the zonal ammonite to demonstrate the presence of the zone. The typography of standard zones distinguishes them from the full, italicized names of less formal zones, *e.g.*, provisional assemblages, zones used for local correlation, single taxa ranges.

(v) One standard zonation is selected as the primary standard to which all secondary standards are correlated with as much precision as possible. In the case



Text-figure 9.—Lithostratigraphy and fossil localities of section C, north shore of Cumshewa Inlet. See Text-figure 6 for legend and Text-figure 18 for the fauna present. Base of section is faulted.

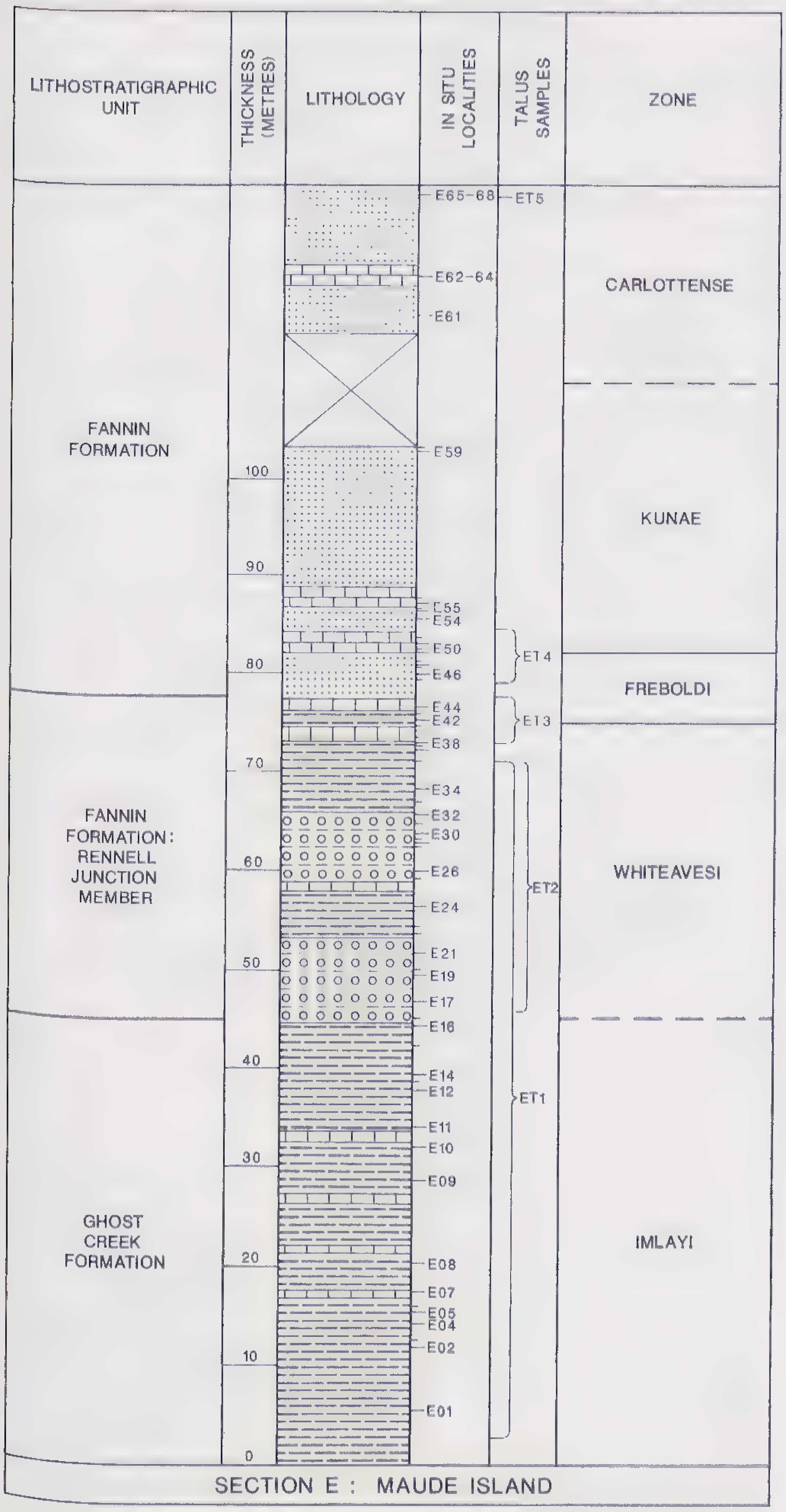


Text-figure 10.—Lithostratigraphy and fossil localities of section D, Whiteaves Bay. See Text-figure 6 for legend and Text-figure 19 for the fauna present.

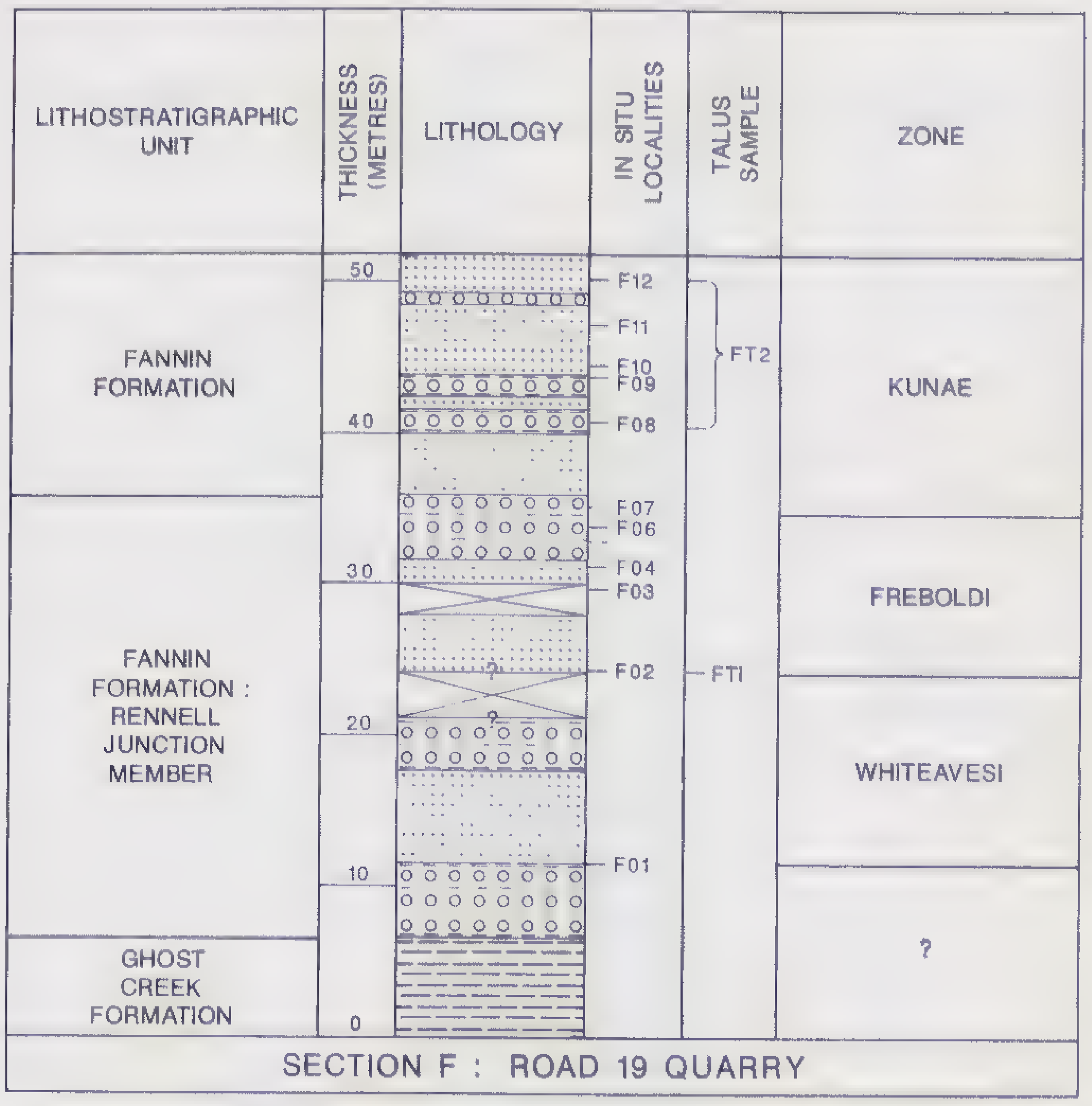
of the Lower Jurassic ammonites discussed in this report, the Northwest European zonation (Dean *et al.*, 1961) is the primary standard and the North American zonation (Smith *et al.*, 1988) is the secondary standard (Text-fig. 5).

The collections on which this report is based were made by the authors and numerous other geologists over the course of many years. The collecting began at the end of the last century and in some cases the same locality has been visited several times by different geologists. To bring some order to this situation we have, where possible, assigned the localities to a standardized labelling system where the letter prefix indicates, from south to north, the measured stratigraphic section and the number indicates, in ascending order, the stratigraphic position of the locality as illustrated in Text-figures 6 to 14. Where specimens were not in place or where there was uncertainty as to stratigraphic position in the case of old collections, the section letter prefix is followed by the letter 'T' denoting talus. We have shown in Text-figures 6 to 13 the approximate stratigraphic interval from which these collections originated. A complete listing of the standardized locality numbers and the original locality numbers is given in the Appendix together with the precise geographic position of the measured stratigraphic sections (A through G), the drilling site (H), and isolated fossil localities (I). Text-figures 16 through 24 indicate the ammonite fauna at each locality and the North American ammonite zones present.

The relationship of the Imlayi Zone to underlying faunal assemblages is the subject of continuing research. It appears that the *Tetraspidoceras* assemblage of Pálfy *et al.* (in press) spans the Sinemurian-Pliensbachian boundary and consequently the base of the Imlayi Zone does not correspond to the base of the Pliensbachian. The Imlayi Zone is the thickest of the Pliensbachian zones recognized in the Queen Charlotte Islands but its fauna is amongst the least diverse. *Pseudoskirroceras* and *Miltoceras* are restricted to the zone whereas species of *Tropidoceras,* that are more characteristic of the upper part of the zone, range upwards



Text-figure 11.—Lithostratigraphy and fossil localities of section E, Fannin Bay, southeast Maude Island. See Text-figure 6 for legend and Text-figure 20 for the fauna present.



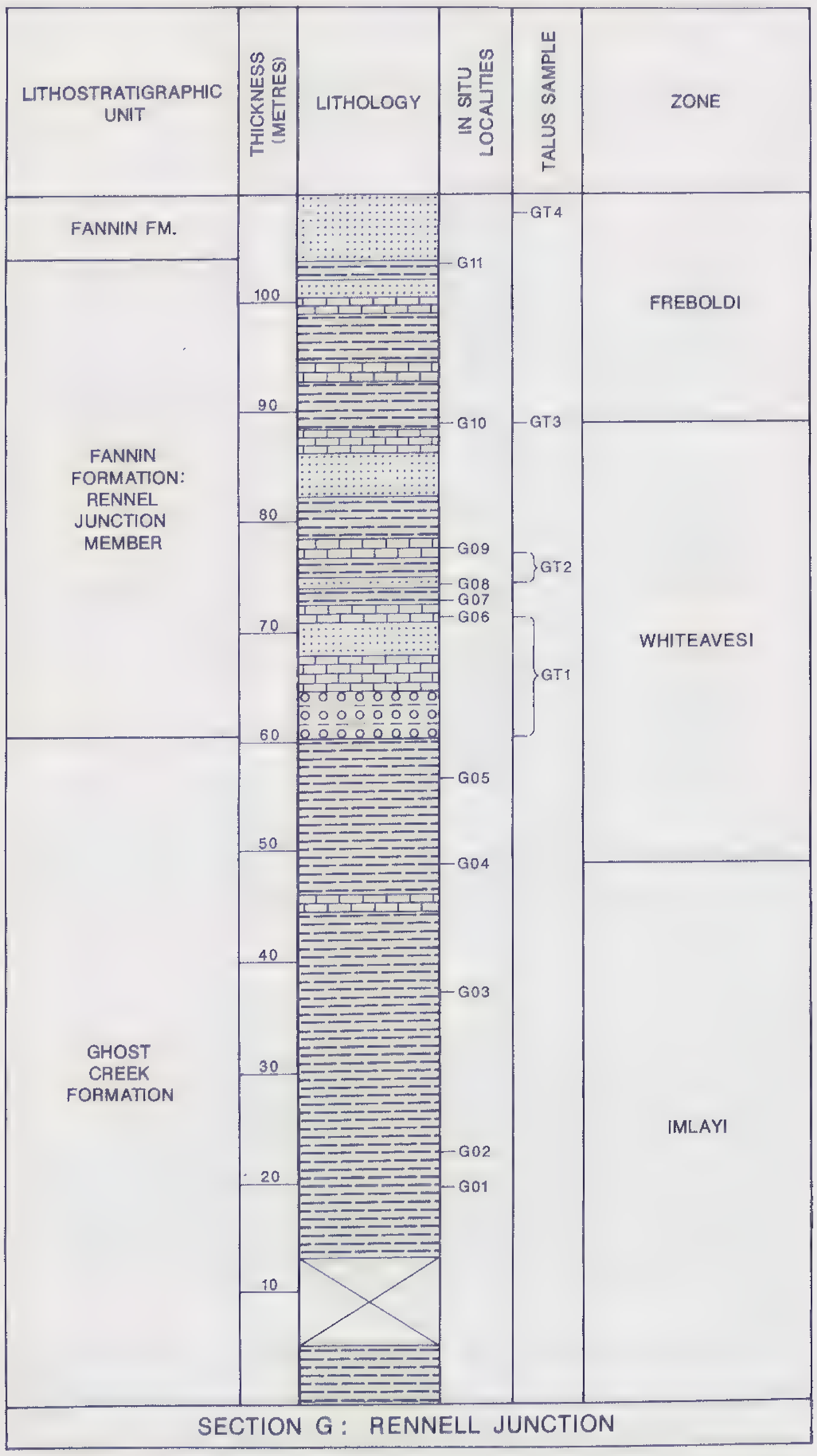
Text-figure 12.—Lithostratigraphy and fossil localities of section F, the Forest Service Road 19 Quarry. See Text-figure 6 for legend and Text-figure 21 for the fauna present.

into the overlying Whiteavesi Zone. The long-ranging genus *Metaderoceras* is represented by the distinctive *M. evolutum* with its long spines and often looped, striate ribs.

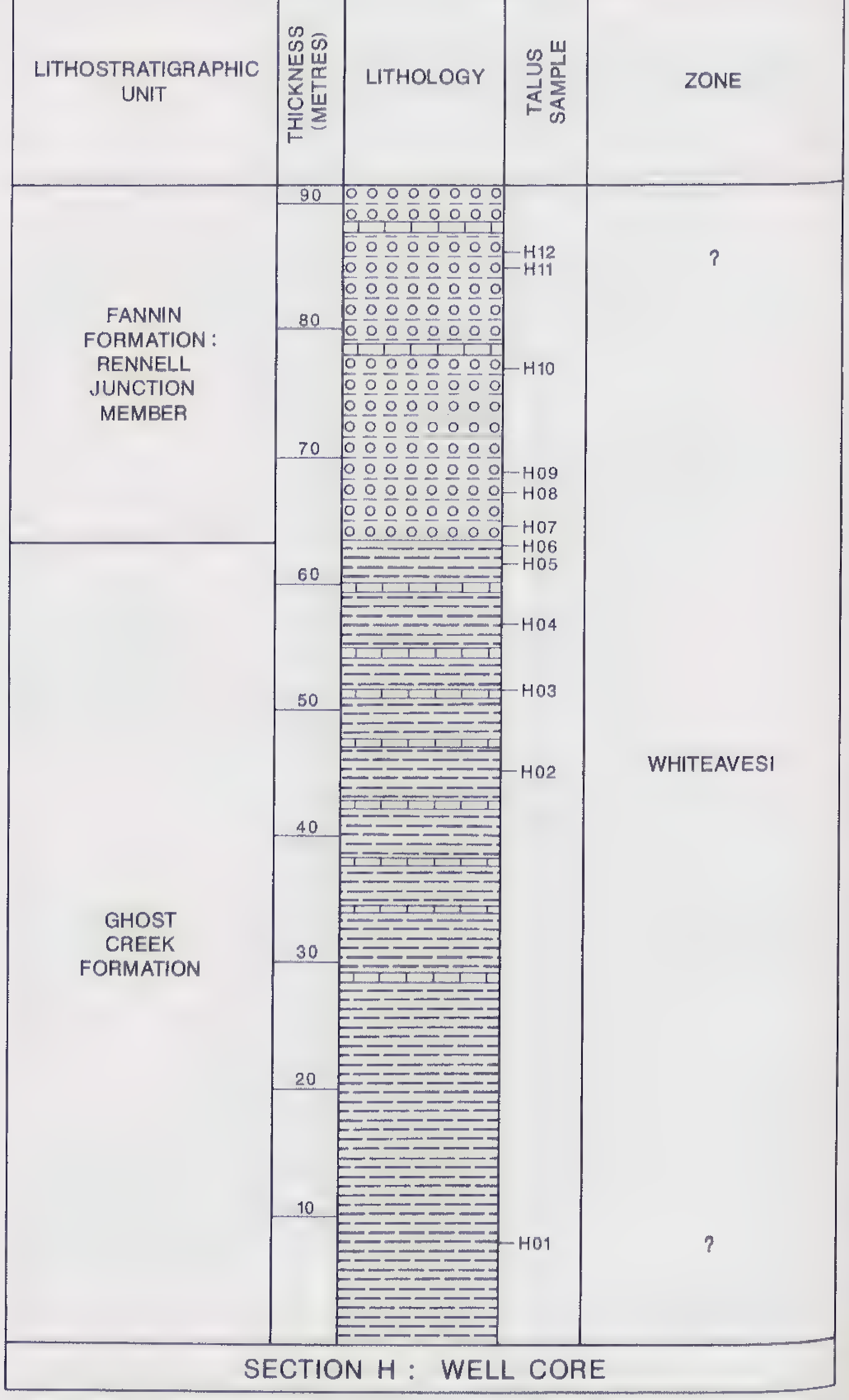
The Whiteavesi Zone fauna is considerably more diverse and characterized by a profusion of acanthopleuroceratids, the first appearance of *Dubariceras (D. silviesi)* and the occurrence of coarse ribbed, robust forms of *Metaderoceras*. In the Freboldi Zone, above the range of the acanthopleuroceratids, diversity drops again to levels comparable with the Imlayi Zone but, in marked contrast to the Imlayi Zone, the Freboldi Zone is amongst the thinnest Pliensbachian zones recognized in the Queen Charlotte Islands. *Dubariceras freboldi* occurs throughout the zone and in the upper part of its range it frequently occurs with species of *Reynesoceras*, most of which range up into the Kunae Zone.

The similarly thin Kunae Zone is remarkable for its quantum jump in diversity to the highest level seen in the Pliensbachian. Some of the increase is accomplished by the appearance of a diverse suite of *Fanninoceras* species but most is caused by the appearance and rapid diversification of the hildoceratids and a proliferation of dactylioceratids ranging up from the Freboldi Zone.

The upper part of the Fannin Formation yields three faunal associations that represent the Pliensbachian-Toarcian transition. Species of *Lioceratoides* and *Protogrammoceras* are present throughout. The lowest association (Carlottense Zone, Sections B and E) is considered Pliensbachian based on the presence of species of *Amaltheus, Arieticeras* and *Fanninoceras;* the anomalous presence of the typically Toarcian *Tiltoniceras* marks the earliest known occurrence of this genus. This association is not thought to be the result of condensing, in spite of its stratigraphic position at the top of a coarsening upwards sequence, because it occurs at different levels over a significant stratigraphic interval,



Text-figure 13.—Lithostratigraphy and fossil localities of section G, Rennell Junction. See Text-figure 6 for legend and Text-figure 22 for the fauna present.



Text-figure 14.—Lithostratigraphy and fossil localities of Well Core H. See Text-figure 6 for legend and Text-figure 23 for the fauna present.

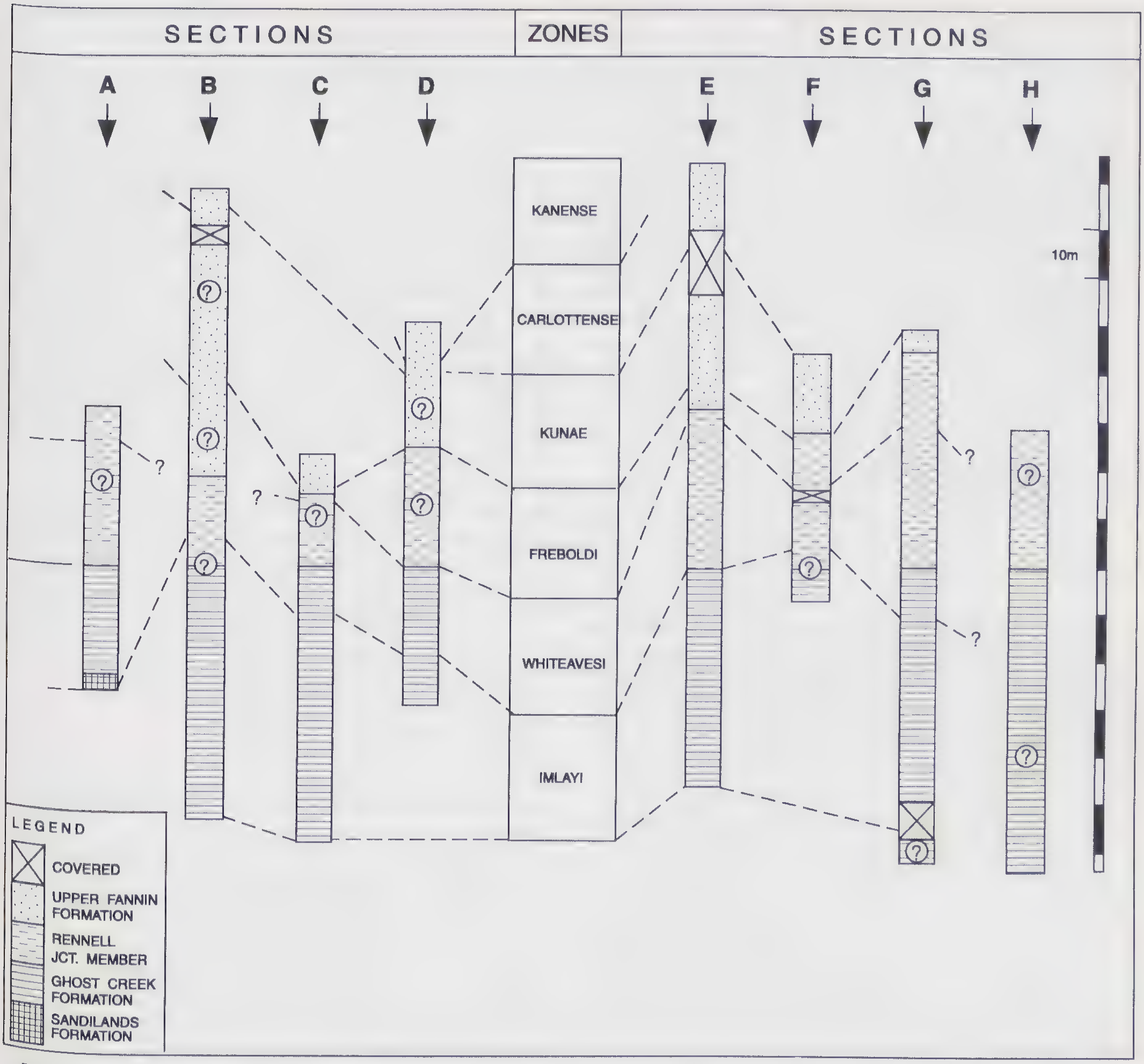
both here and elsewhere in North America (Thomson and Smith, 1992).

A middle association consisting only of species of *Lioceratoides* and *Protogrammoceras* is of uncertain position but is included within the Carlottense Zone of the Pliensbachian because of the absence of *Dactylioceras* (localities D24, D25 and I03). The highest association (localities D26 and D27) includes species of *Lioceratoides, Protogrammoceras* and *Tiltoniceras*; it is unequivocally Toarcian since it also includes *Dactylioceras* and, slightly higher, in the uppermost Fannin Formation, a representative of *Taffertia* (Jakobs *et al.*, 1994b).

SYSTEMATIC PALEONTOLOGY

Introduction

Taxonomic groups are held to have a common ancestry (Donovan, 1994). Ammonoids are notorious for heterochronous homeomorphy and therefore it is important that before a specimen is identified, its age is constrained as closely and confidently as possible by co-occuring and stratigraphically subjacent and superjacent assemblages. For Jurassic ammonoids, septal sutures are of utility at high taxonomic levels, notably in the case of the Queen Charlotte Islands' fauna for distinguishing phylloceratids with their phylloid lobes, from the ammonites proper. Families represent distinct changes in morphology, usually involving shell geometry and features of the venter. Genera are inter-



Text-figure 15.—Correlation of Pliensbachian units in the Queen Charlotte Islands. Correlation lines are drawn at the incoming of faunas and question marks indicate no, or poor biostratigraphic control.

preted to represent lineages; they are characterized by their shell geometry, whorl shape, ornamentation and consistent patterns of ontogenetic change. Subgeneric status is accorded to derivative forms showing new or incipient features that lead to new taxa. The recognition of species usually requires a large enough sample to demonstrate discontinuous variation, particularly involving whorl shape and ornamentation. When extreme variations are stratigraphically or geographically limited they may be designated as subspecies. We do not recommend the use of this taxonomic level even though we have occasionally employed subspecies erected by others. We suspect that widespread sampling would demonstrate a morphological spectrum that is more continuous in space and time than is presently evident.

Our use of open nomenclature essentially follows Bengston (1988). The term "*aff.*" denotes a new species that we cannot name because of small sample size, stratigraphic uncertainties, or other ambiguities. "*Confer*" meaning "to compare" and abbreviated "*cf.*", is used to denote a provisional identification when poor preservation precludes confidence. We use a question mark to denote uncertainty, usually at the genus-level.

SECTION A: KUNGA ISLAND

	LOCALITIES												
TAXA	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
Reynesoceras italicum													●
Metaderoceras spp.													●
Dubariceras freboldi												●	●
Metaderoceras talkeetnaense											●		
Metaderoceras? spp.									●				
Tropidoceras cf. flandrini flandrini								●					
Tropidoceras spp.							●						
Acanthopleuroceras whiteavesi						●							
Acanthopleuroceras thomsoni						●		●		●			
Tropidoceras actaeon				●	●								
Metaderoceras evolutum			●		●								
Tropidoceras cf. *erythraeum*		●											
Acanthopleuroceras cf. *whiteavesi*	●	●											
Tropidoceras cf. *masseanum rotunda*	●												
ZONE	W	W	W	W	W	W	W	W	W	W	?	F	F

Text-figure 16.—The ammonite fauna and biostratigraphy of section A. See Text-figure 7 for stratigraphic details and Text-figure 6 for the legend.

Throughout the systematics section under "Occurrence" there is a summary of the age of a species in other parts of the world using the European primary standard zonation (Dean *et al.*, 1961). Occurrences in North America other than in the Queen Charlotte Islands are also listed and referred to the North American standard zonation (Smith *et al.*, 1988). The sections headed "Localities" and "Age" only list locality numbers and North American zone assignments for the Queen Charlotte Island ammonites described in this report.

It is not always possible to be precise about the number of specimens representing a species because earlier collections sometimes contain fragments of inner and outer whorls that may or may not belong to the same specimen. On several occasions we have been able to assemble an individual from fragments collected by different people at different times. In spite of this imprecision, the data give a reasonably accurate impression of the relative abundance of species in the Queen Charlotte Islands.

Terminology and Abbreviations

The morphologic terminology used in the systematic descriptions follows that of Smith (1986). All measurements are in millimeters with approximate figures preceded by "c" (*circa*). The abbreviations denoting the measurements used are defined as follows:

D = shell diameter
UD = umbilical diameter at diameter D
U = (UD/D) × 100
WH = whorl height at diameter D
WHD = (WH/D) × 100
WW = whorl width at diameter D
WWD = (WW/D) × 100
WWWH = (WW/WH) × 100

The following parameters are counted on the half whorl terminating at the shell diameter or umbilical diameter indicated:

PRHW = primary ribs per half whorl
SRHW = secondary ribs per half whorl
THW = tubercles per half whorl.

The mean and standard deviation are given for standardized measurements (U, WWD, WHD and WWWH) unless there is a marked change during ontogeny or the dataset is small. Approximate figures are not used in the calculations.

All fossil material referred to in this report is housed in the type collection of the Geological Survey of Canada in Ottawa, hence each specimen is assigned a Geological Survey of Canada (GSC) type number.

SYSTEMATICS

Class **CEPHALOPODA** Cuvier, 1797

Order **AMMONOIDEA** Zittel, 1884

Suborder **PHYLLOCERATINA** Arkell, 1950

Family **PHYLLOCERATIDAE** Zittel, 1884

Genus **PHYLLOCERAS** Suess, 1865

Type species.—Ammonites heterophyllus J. Sowerby, 1820, pl. 226 designated by Suess (1865, p. 76).

SECTION B: LOUISE ISLAND

TAXA	LOCALITIES 1	2	T1	3	4	5	6
Tiltoniceras antiquum							●
Protogrammoceras (P.) aequiondulatum							●
Fanninoceras (Fanninoceras) carlottense							●
Reynesoceras mortilleti						●	
Reynesoceras spp.						●	
Polymorphites confusus					●		
Gemmellaroceras aenigmaticum					●		
Dubariceras silviesi					●		
Acanthopleuroceras thomsoni					●		
Acanthopleuroceras whiteavesi				●			
Miltoceras aff. *sellae*			○				
Metaderoceras spp.			○				
Metaderoceras evolutum			○				
Pseudoskirroceras imlayi	●	●	○				
ZONE	I	I	I	W	W	K	C

Text-figure 17.—The ammonite fauna and biostratigraphy of section B. See Text-figure 8 for stratigraphic details and Text-figure 6 for the legend.

SECTION C: CUMSHEWA INLET

TAXA	LOCALITIES T1	1	T2	2	3	4	5
Fanninoceras (Fanninoceras) fannini						●	
Metaderoceras? aff. *mouterdei*					●		●
Metaderoceras talkeetnaense					●		
Dubariceras freboldi					●		
Tropidoceras masseanum rotunda				●			
Acanthopleuroceras cf. *whiteavesi*				●			
Acanthopleuroceras sp.			○				
Tropidoceras spp.	○	●					
Pseudoskirroceras imlayi		●					
Miltoceras sp.		●					
Miltoceras aff. *sellae*	○						
ZONE	I	I	W	W	F	K	C

Text-figure 18.—The ammonite fauna and biostratigraphy of section C. See Text-figure 9 for stratigraphic details and Text-figure 6 for the legend.

Remarks.—Compressed involute forms with very fine ornamentation that is not visible on internal molds.

Age and distribution.—A long-ranging genus (Sinemurian to Valanginian) that is cosmopolitan in its distribution but becomes locally abundant in the circum-Mediterranean region.

Phylloceras bonarellii Bettoni, 1900
Plate 1, figure 1;
Text-figures 25c, 26b

Phylloceras n. sp. indet. Gemmellaro, 1884, p. 176, pl. 2, figs. 11, 12.
Phylloceras zetes d'Orbigny. Fucini, 1900, p. 4, pl. 1, fig. 4.
Phylloceras bonarellii Bettoni, 1900, p. 41, pl. 3, fig. 9; Fucini, 1901b, p. 38, pl. 6, fig. 3; Pia, 1913, p. 364, pl. 13, fig. 4.
Phylloceras cf. *bonarellii* Bettoni. Monestier, 1934, p. 13, pl. 9, figs. 20, 22; pl. 11, fig. 21.
Zetoceras bonarellii (Bettoni). Wiedenmayer, 1977, p. 22, pl. 6, fig. 2.

Description.—Involute, compressed form with a rounded umbilical shoulder, flat subparallel flanks, and a broadly rounded venter. The figured specimen is completely septate so that a fairly large size was reached.

SECTION D: WHITEAVES BAY

TAXA	LOCALITIES 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	T1	T2	24	25	26	27
Tiltoniceras antiquum																									○				●
Lioceratoides (L.) sp. juv.																									○			●	
Dactylioceras kanense																												●	●
Protogrammoceras (P.) skidegatense																										●	●		
Protogrammoceras (P.) kurrianum																										●			
Protogrammoceras (P.) cf. *paltum*																										●	●	●	●
Lioceratoides (Pacificeras) propinquum																									○	●	●	●	●
Lioceratoides (Pacificeras) angionus																										●			
Lioceratoides (L.) allifordense																									○	●		●	
Lioceratoides (L.) maurelli																									○				
Reynesoceras ragazzonii																								○					
Arieticeras lupheri																								○					
Reynesocoeloceras mortilleti																						●		○					
Arieticeras cf. *micrasterias*																						●							
Reynesoceras colubriforme																					●								
Protogrammoceras (Matteiceras) cf. *diornatum*																				●									
Phylloceras sp																				●									
Leptaleoceras sp.																				●			●	○					
Fontanelliceras sp.																				●		●							
Fanninoceras (Fanninoceras) fannini																				●									
Fanninoceras (Charlotticeras) maudense																				●									
Fieldingiceras pseudofieldingii																			●	●									
Metaderoceras talkeetnaense																●	●	●											
Dubariceras freboldi													●	●	●			●											
Phylloceras bonarellii								●												●									
Tropidoceras masseanum rotunda						●	●	●		●	●																		
Tropidoceras flandrini flandrini				●			●																						
Tropidoceras actaeon			●		●	●	●	●		●	●	●																	
Metaderoceras evolutum			●		●		●	●	●	●																			
Acanthopleuroceras whiteavesi		●					●				●																		
Tropidoceras sp 1	●																												
Tropidoceras flandrini obtusa	●							●																					
ZONE	1?	W	W	W	W	W	W	W	W	W	W	W	F	F	F	F	F	F	K	K	K	K	K	K	K	C	C	T	T

Text-figure 19.—The ammonite fauna and biostratigraphy of section D. See Text-figure 10 for stratigraphic details and Text-figure 6 for the legend.

SECTION F: ROAD 19 QUARRY

	LOCALITIES													
TAXA	1	T1	2	3	4	5	6	7	T2	8	9	10	11	12
Fuciniceras? sp.									○					●
Leptaleoceras? sp.									○				●	
Reynesocoeloceras? sp.											●			
Reynesocoeloceras mortilleti									○					
Reynesoceras sp.									○					
Protogrammoceras (Protogrammoceras) sp.									○	●		●		
Protogrammoceras (Matteiceras) cf. *diornatum*									○					
Phylloceras bonarellii									○					
Genus and species indet.									○					
Liparoceras (Becheiceras) bechei									○					
Fieldingiceras sp.									○					
Fieldingiceras pseudofieldingii									○					
Fanninoceras (Fanninoceras) kunae									○					
Arieticeras sp.									○					
Amaltheus stokesi									○					
Fanninoceras (Fanninoceras) fannini								●	○					
Fanninoceras (Fanninoceras) spp.							●			●				
Dubariceras freboldi		○			●	●	●							
Reynesocoeloceras cf. *incertum*			●											
Metaderoceras talkeetnaense		○	●											
Metaderoceras mouterdei		○	●											
Reynesocoeloceras grahami		○												
Phylloceras spp.		○	●	●										
Oistoceras compressum		○	●											
Gemmellaroceras spp.		○												
Dubariceras silviesi		○												
Tropidoceras actaeon	●													
ZONES	W	F	F?	F?	F	F	F	K	K	K	K	K	K	---

Text-figure 21.—The ammonite fauna and biostratigraphy of section F. See Text-figure 12 for stratigraphic details and Text-figure 6 for the legend.

Type material.—Lectotype: Bettoni, 1900, pl. 3, fig. 9 designated by Fantini Sestini, 1974, p. 226.

Material.—Approximately 14 specimens, only one of which is well preserved, in siltstone and fine grained calcareous sandstone of the Ghost Creek and Fannin formations.

Measurements.—See Table 1.

Occurrence.—In the Old World this species occurs in the Tethyan faunas of southern Europe where it ranges from the Jamesoni to the Spinatum Zone (Fantini Sestini, 1974; Wiedenmayer, 1977;).

Localities.—DO8, D20, E27, ET4, FT2, GT3, G02, I14.

Age.—Imlayi to Kunae Zone (Pliensbachian).

Phylloceras sp.

Plate 1, figures 2, 3; Text-figures 25a-b, 26a

Partschiceras? Imlay, 1968, p. C26, pl. 1, figs. 14, 15.
Phylloceras sp. Thomson and Smith, 1992, pl. 3, fig. 5.

Description.—Very involute forms with a compressed whorl section. The flanks are gently convex to almost flat and diverge weakly towards the venter. The venter is broad and gently rounded. The specimens are all smooth internal molds. First and second lateral saddles triphyllic.

Material.—Eleven internal molds in fine grained calcareous sandstone of the Rennell Junction Member of the Fannin Formation.

Measurements.—See Table 2.

Discussion.—This form shows some similarities to the species *Phylloceras frondosum* (Reynès) and *P. waehneri* (Gemmellaro). *P. frondosum* is slightly less involute with a narrower venter and *P. waehneri* has more rounded flanks and a narrower venter.

Occurrence.—*P. frondosum* ranges throughout the Pliensbachian; *P. waehneri* has only been reported from the Lower Pliensbachian (Fantini Sestini, 1974).

Localities.—D20, ET1, E27, E55, FT2, F02.

Age.—Whiteavesi and Kunae zones (Pliensbachian).

Family **JURAPHYLLITIDAE** Arkell, 1950

Genus **TRAGOPHYLLOCERAS** Hyatt, 1900

Phyllolobites Vadász, 1907, p. 352.

Type species.—*Ammonites heterophyllus numismalis* Quenstedt, 1845, p. 100, pl. 6, figs. 4a,b; 5a,b, by original designation (Hyatt, 1900, p. 568).

SECTION G: RENNELL JUNCTION

TAXA	LOCALITIES 1	2	3	4	5	T1	6	7	8	9	T2	10	T3	11	T4
Liparoceras (Becheiceras) bechei															○
Fanninoceras (Fanninoceras) kunae															○
Fanninoceras (Fanninoceras) fannini															○
Fanninoceras (Fanninoceras) crassum															○
Arieticeras disputabile															○
Amaltheus stokesi															○
Reynesocoeloceras mortilleti													○		
Reynesocoeloceras grahami													○		
Gemmellaroceras aenigmaticum													○		
Dubariceras freboldi											○	●	○	●	
Metaderoceras mouterdei										●			○		
Tropidoceras masseanum rotunda							●						○		
Metaderoceras talkeetnaense						○	●	●	●	●	○		○		
Metaderoceras evolutum						○	●								
Reynesocoeloceras spp.						○									
Dubariceras silviesi						○							○		
Acanthopleuroceras thomsoni						○							○		
Tropidoceras actaeon					●	○				●					
Acanthopleuroceras whiteavesi				●											
Tropidoceras flandrini flandrini			●	●											
Polymorphites confusus	●		●		●					●					
Phylloceras bonarellii		●											○		
Tropidoceras sp. 1	●														
Tropidoceras cf. *erythraeum*	●	●	●												
Pseudoskirroceras imlayi	●	●	●												
Miltoceras aff. *sellae*	●	●	●												
Gemmellaroceras cf. *alloplocum*	●		●	●											
ZONES	I	I	I	W	W	W	W	W	W	W	---	F	---	F	K

Text-figure 22.—The ammonite fauna and biostratigraphy of section G. See Text-figure 13 for stratigraphic details and Text-figure 6 for the legend.

Remarks.—Phylloceratines with compressed whorl sections and an open umbilicus. Constrictions are apparent on internal molds. Ornamentation is flexuous and strengthens ventrally. The genus has been discussed by Howarth and Donovan (1964), and Meister (1986).

Age and distribution.—The family Juraphyllitidae in Europe is predominantly Tethyan in its distribution with the exception of *Tragophylloceras* which is characteristic of, but not restricted to, northwest Europe. The genus ranges from the Jamesoni to the Margaritatus Zone.

Tragophylloceras new species?
Plate 1, figure 6

Tragophylloceras sp. Imlay, 1968, p. C26, pl. 1, figs. 10, 11.

Description.—Involute form with a compressed whorl section. The umbilical wall is very low and steep, the umbilical shoulder abrupt, the flanks flat and the venter

SECTION H: WELL CORE

TAXA	LOCALITIES 1	2	3	4	5	6	7	8	9	10	11	12
Metaderoceras talkeetnaense										●	●	●
Acanthopleuroceras thomsoni								●	●			
Tropidoceras flandrini flandrini				●								
Tropidoceras actaeon		●	●		●	●	●					
Polymorphites confusus	●											
ZONE	---	W?	W?	W?	W?	W?	W?	W	W	---	---	---

Text-figure 23.—The ammonite fauna and biostratigraphy of well core H. See Text-figure 14 for stratigraphic details and Text-figure 6 for the legend.

ISOLATED LOCALITIES

TAXA	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Acanthopleuroceras thomsoni	○	●														●	
Acanthopleuroceras whiteavesi																●	
Arieticeras disputabile														●			
Arieticeras lupheri						●											
Arieticeras aff. *algovianum*														●			○
Arieticeras aff. *domarense*						●											○
Arieticeras cf. *micrasterias*																	○
Arieticeras cf. *ruthenense*						●								●			
Cymbites centriglobus														●			
Cymbites laevigatus														●			
Dubariceras freboldi	○						●								●		
Dubariceras silviesi	○	●					●										
Fanninoceras (Fanninoceras) carlottense						●											
Fanninoceras (Charlotticeras) carteri						●	●							●			
Fanninoceras (Fanninoceras) fannini						●	●										○
Fanninoceras (Fanninoceras) kunae						●											
Fanninoceras (Charlotticeras) maudense						●											
Fieldingiceras pseudofieldingii						●	●										
Fontanelliceras sp.														●			
Fuciniceras aff. *intumescens*						●											
Fuciniceras cf. *targionii*																	○
Gleviceras? sp.		●															
Leptaleoceras compressum						●											
Leptaleoceras aff. *accuratum*																	○
Leptaleoceras sp.						●								●			
Lioceratoides (L.) allifordense			●														
Lioceratoides (Pacificeras) propinquum			●									●					
Metaderoceras evolutum								●								●	
Metaderoceras mouterdei		●															
Metaderoceras talkeetnaense		●					●								●		
Phricodoceras cf. *taylor*								●									
Phylloceras bonarellii														●			
Protogrammoceras (Matteiceras) cf. *diornatum*						●											
Protogrammoceras (P.) cf. *paltum*			●														
Protogrammoceras (P.) sp.							●										
Pseudoskirroceras imlayi								●	●	●	●						
Reynesoceras colubriforme							●							●			
Reynesoceras italicum					●	●											
Reynesoceras ragazzonii						●											
Reynesocoeloceras mortilleti						●									●		
Reynesocoeloceras spp.		●															
Tropidoceras actaeon		●															
Tropidoceras flandrini flandrini								●									
Tropidoceras flandrini obtusa								●									
Tropidoceras masseanum rotunda		●															
Tropidoceras cf. *erythraeum*								●	●	●	●						
Tropidoceras aff. *rursicosta*								●			●		○				
Tropidoceras n. sp. 1		●															
Tropidoceras sp. 1				●				●			●						
ZONE	---	W	C	---	K?	K	F+K	I	I	I	I	C	I	K	F	W	K
LITHOLOGIC UNIT	R	R	Fa	G	Fa	Fa	R+Fa	G	G	G	G	Fa	G	Fa	R	G	Fa

Text-figure 24.—The ammonite fauna found at isolated localities on southern Graham Island.

narrow. Weak, broad primary ribs arise low on the flank and trend gently prorsiradiately to the upper quarter of the flank where numerous fine secondary ribs arise and the ribbing flexes slightly more prorsiradiately onto the venter. The phylloceratine septal suture line is partially exposed at the largest shell diameter where the shell has been removed.

Material.—One specimen collected from calcareous sandstone of the Fannin Formation.

Measurements.—See Table 3.

Discussion.—This phylloceratine is placed in *Tragophylloceras* because of its narrow whorl section, its fairly open umbilicus and its costation. This species is also known from a bed of the Kunae Zone in Oregon (Imlay, 1968). As Imlay remarked, the species shows some similarities to the European forms *T. loscombi* and *T. undulatum.* The differences, however, are such that the North American specimens should be tenta-

Table 1.—Measurements of *Phylloceras bonarellii* Bettoni, 1900. All measurements are in mm.

specimen no.	*D*	*UD*	*U*	*WW*	*WWD*	*WH*	*WHD*	*WW-WH*
GSC 98693	51.6	5	9.7	16.7	32.4	28.4	55	58.8

tively regarded as a new species that can only be properly described when more material has been collected.

Occurrence.—In Europe, *T. loscombi* is the only species of *Tragophylloceras* to persist into the Upper Pliensbachian (Howarth and Donovan, 1964; Meister, 1989). The two specimens of *Tragophylloceras* now known from North America (from eastern Oregon and the Queen Charlotte Islands) are both of probable Late Pliensbachian age.

Locality.—ET4.

Age.—probably Kunae Zone (Late Pliensbachian)

Suborder **AMMONITINA** Hyatt, 1889

Superfamily **PSILOCERATACEAE** Hyatt, 1867

Family **CYMBITIDAE** Buckman, 1919

Genus **CYMBITES** Neumayr, 1878

Metacymbites Spath, 1923, p. 76.

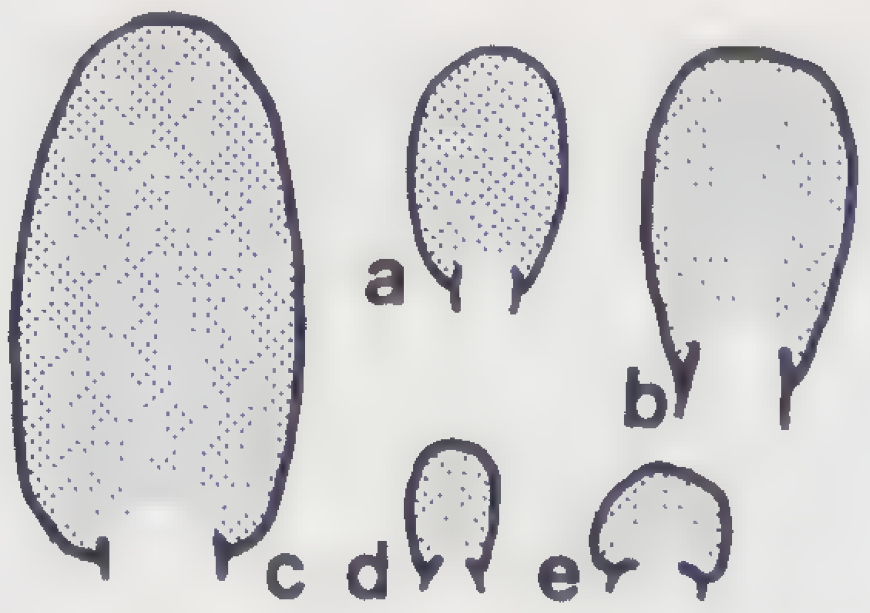
Type species.—*Ammonites globosus* Schubler *in* Zieten, 1832, p. 37, pl. 28, fig. 2 by original designation (Neumayr, 1878, p. 64).

Remarks.—Small involute to midvolute forms, with depressed or rounded whorl section. Smooth or very weakly ornamented. The last whorl commonly egresses and the aperture may be constricted and bear a rostrum. Septal suture simple.

Age and distribution.—The genus has been reported from rocks that range in age from the Sinemurian to Pliensbachian. Often locally abundant at a given horizon, it has been previously reported from Great Britain (Donovan, 1957), Germany (Schindewolf, 1961), Italy (Fucini, 1899), Portugal (Mouterde, Dommergues, and Rocha, 1983), Switzerland (Bettoni, 1900), France (Monestier, 1934), and the United States (Imlay, 1968). The genus appears to have been geographically more widespread in the Pliensbachian than the Sinemurian.

Table 2.—Measurements of *Phylloceras* sp. All measurements are in mm.

specimen no.	*D*	*UD*	*U*	*WW*	*WWD*	*WH*	*WHD*	*WW-WH*
GSC 98575	22.4	1.5	6.7	9.5	42.4	12.3	54.9	77.2
GSC 98574	18.3	1.2	6.6	c7.8	42.6	10.5	57.4	c74.3



Text-figure 25.—Whorl shape cross-sections for species of the Phylloceratidae and Cymbitidae. Figures are natural size unless otherwise indicated. a-b. *Phylloceras* sp. (a. GSC 98574; b. GSC 98575); c. *Phylloceras bonarellii* Bettoni, 1900 (GSC 98693); d. *Cymbites laevigatus* (J. de Sowerby, 1827) (GSC 98580) (×1.3); e. *Cymbites centriglobus* (Oppel, 1862) (GSC 98577) (×1.3).

Cymbites centriglobus (Oppel, 1862)
Plate 1, figures 7–9,
Text-figures 25e, 26d

Ammonites globosus Oppel, 1853, p. 95, pl. 3, fig. 7; Quenstedt, 1856, p. 172, pl. 21, figs. 8, 9; 1885, p. 336, pl. 42, figs. 29, 30, 32–36.
Ammonites centriglobus Oppel, 1862, p. 140.
Cymbites centriglobus (Oppel). Fucini, 1900, p. 19, pl. 3, figs. 5, 6; Schindewolf, 1961, p. 216, pl. 31, figs. 1–18; Schlegelmilch, 1976, p. 52, pl. 22, fig. 3; Mouterde, Dommergues, and Rocha, 1983, p. 194, pl. 12, figs. 11–13; Meister, 1986, p. 64, pl. 11, fig. 5; 1989, p. 34, pl. 3, fig. 9.
Agassiceras centriglobum (Oppel). Bettoni, 1900, p. 52, pl. 8, fig. 4; Monestier, 1934, p. 27, pl. 3, figs. 4–11.
Metacymbites centriglobus (Oppel). Spath, 1938, p. 95, pl. 10, fig. 8; pl. 11, figs. 6–8; Howarth, 1957, p. 196, pl. 17, figs. 3, 4.
Metacymbites? cf. *M. centriglobus* (Oppel). Imlay, 1968, p. C27, pl. 1, figs. 1–6.

Description.—Small, involute smooth forms with a depressed whorl section. At shell diameters of approximately 8 mm, the last whorl begins to uncoil and becomes slightly compressed. The body chamber, which occupies about half a whorl at maturity, terminates in a constriction and a broad rostrum.

Type material.—Quenstedt (1862) established this species referring to the material figured by Oppel (1853, pl. 3, fig. 7) which subsequent workers took as the type (Schindewolf, 1961); this specimen is now considered lost. Quenstedt (1862) also referred to material figured by Quenstedt (1856, pl. 21, fig. 9; refigured in Quenstedt, 1885, pl. 42, fig. 30) when he established the species and this specimen was refigured and designated as the neotype by Schlegelmilch (1976).

Table 3.—Measurements of *Tragophylloceras* new species? All measurements are in mm.

specimen no.	*D*	*UD*	*U*	*WW*	*WWD*	*WH*	*WHD*	*WW-WH*
GSC 98581	20.7	4	19.3	4.7	22.7	10.2	49.3	46.1

Table 4.—Measurements of *Cymbites centriglobus* (Oppel, 1862). All measurements are in mm.

specimen no.	*DMAX*	*DPHRAG*	*D*	*UD*	*U*	*WW*	*WWD*	*WH*	*WHD*	*WWWH*
GSC 98577	11.4	c7.5	10.6	3	28.3	4.9	46.2	4.6	43.4	106.5
GSC 98576	—	—	9.8	2.4	24.5	4.8	49	4.6	46.9	104.3
GSC 98578	10.9	9.0	10.9	2.9	26.6	5.0	45.9	4.5	41.2	111.1
MEAN					26.4		47		43.8	107.3
ST. DEV.					1.9		1.7		2.9	3.5

Material.—Sixteen internal molds in calcareous sandstone of the Fannin Formation.

Measurements.—See Table 4.

Discussion.—*Cymbites centriglobus* can be distinguished from *C. laevigatus,* with which it co-occurs, by its globose shell with its broad venter and depressed whorl section.

Occurrence.—The species is widely distributed in both southern and northwestern Europe where it ranges in age from the Obtusum to the Margaritatus Zone with its acme in the Margaritatus Zone. Outside Europe, the species has only been reported from the Late Pliensbachian Nicely Formation in east-central Oregon (Imlay, 1968).

Localities.—ET4, I14.

Age.—Kunae Zone (Late Pliensbachian).

Cymbites laevigatus
(J. de C. Sowerby, 1827)
Plate 1, figures 4, 5; Text-figure 25d

Ammonites laevigatus J. de C. Sowerby, 1827, p. 135, pl. 570, fig. 3.
Cymbites subcostulatus Spath, 1926, p. 170, pl. 11, fig. 3.
Cymbites laevigatus (J. de C. Sowerby). Donovan, 1957, p. 413, figs. 1–8; Schindewolf, 1961, p. 208, pl. 29, fig. 17; pl. 30, figs. 1–7; Schlegelmilch, 1976, p. 52, pl. 22, fig. 4.

Description.—Small forms with equant to slightly depressed whorls that become compressed as the last whorl egresses. The body chamber is probably a little over half a whorl although last sutures are not clearly preserved. The mature body chamber terminates in a narrow, fairly deep constriction followed by a rostrum.

Type material.—Holotype: *Ammonites laevigatus* J. de C. Sowerby, 1827, p. 135, pl. 570, fig. 3.

Material.—Three internal molds with some shell material, preserved in calcareous sandstone of the Fannin Formation.

Measurements.—See Table 5.

Discussion.—Differs from *C. centriglobus* by its more compressed whorl section, deeper terminal constriction and a more developed rostrum.

Text-figure 26.—Traces of the septal suture for species of the Phylloceratidae, Cymbitidae, Polymorphitidae and Dactylioceratidae at whorl heights (WH) indicated. a. *Phylloceras* sp. (GSC 98575, WH = 12.3 mm); b. *Phylloceras bonarellii* Bettoni, 1900 (GSC 98693, WH = 15 mm); c. *Acanthopleuroceras whiteavesi* Smith and Tipper, 1988 (Paratype GSC 87791, WH = 15 mm); d. *Cymbites centriglobus* (Oppel, 1862) (GSC 98578, WH = 3 mm); e. *Gemmellaroceras aenigmaticum* (Gemmellaro, 1884) (GSC 98632, WH = 2.3 mm); f. *Reynesocoeloceras mortilleti* (Meneghini, 1875) (GSC 98673, WH = 8 mm).

Occurrence.—*C. laevigatus* arises in the Turneri Zone and is most common in the Upper Sinemurian but it ranges as high as the Margaritatus Zone. It is characteristic of Northwest Europe. The Queen Charlotte Islands occurrence represents the first report of this species in the circum-Pacific region.

Localities.—ET4, I14.

Age.—Kunae Zone (Late Pliensbachian).

Family **OXYNOTICERATIDAE** Hyatt, 1875

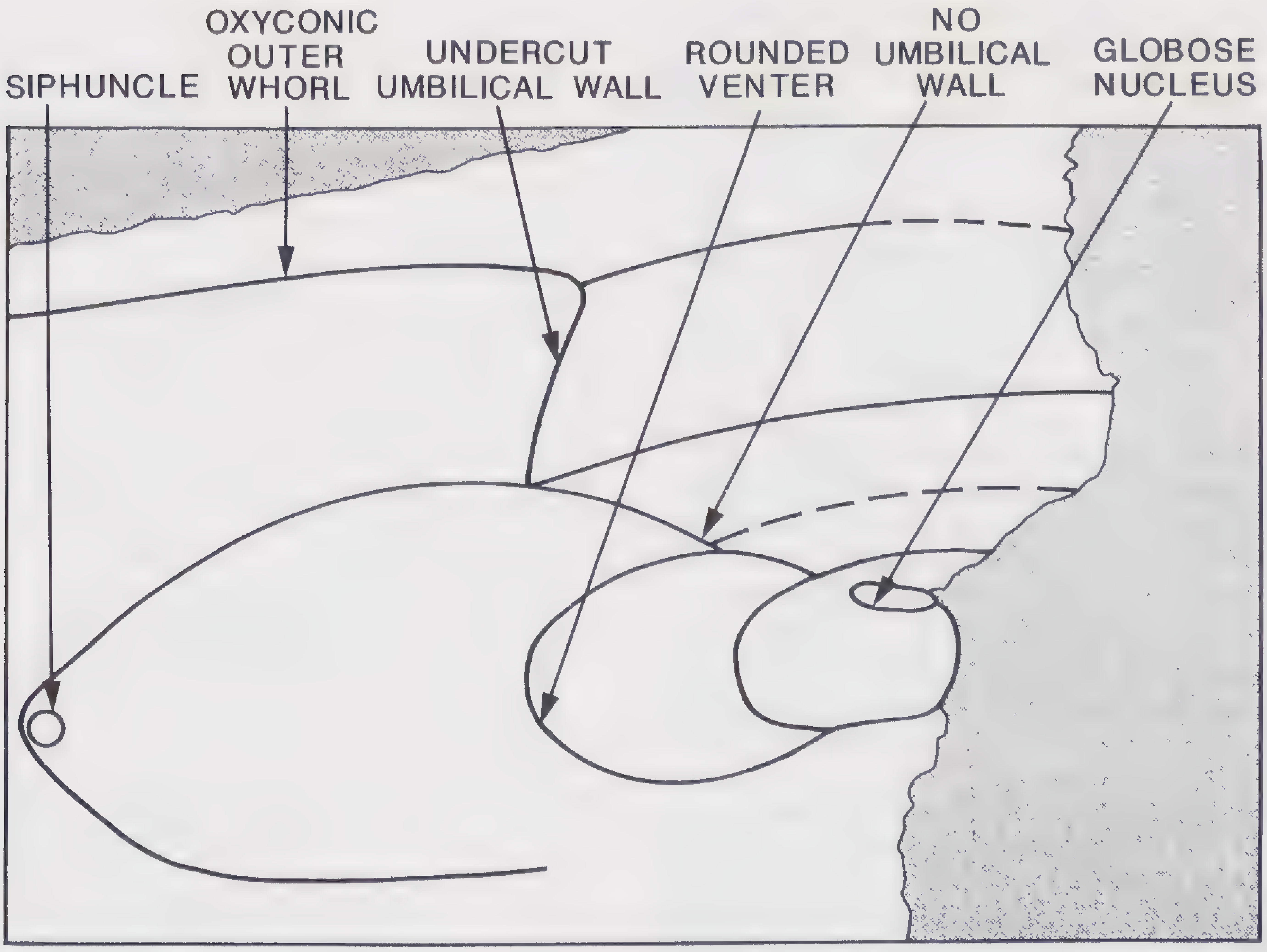
Genus **FANNINOCERAS** McLearn, 1930

Subgenus **FANNINOCERAS** McLearn, 1930

Type species.—*Fanninoceras fannini* McLearn, 1930, p. 4, pl. 1, fig. 3.

→

Text-figure 27.—A specimen of *Fanninoceras (Fanninoceras) fannini* broken open to show the inner whorls. Whorl shape changes from the depressed, globose inner whorls to compressed, oxyconic outer whorls. As these changes occur, the umbilical wall becomes progressively more undercut and the ribbing commonly disappears. The scale at the bottom of the photograph is in millimeters.


SIPHUNCLE
OXYCONIC OUTER WHORL
UNDERCUT UMBILICAL WALL
ROUNDED VENTER
NO UMBILICAL WALL
GLOBOSE NUCLEUS

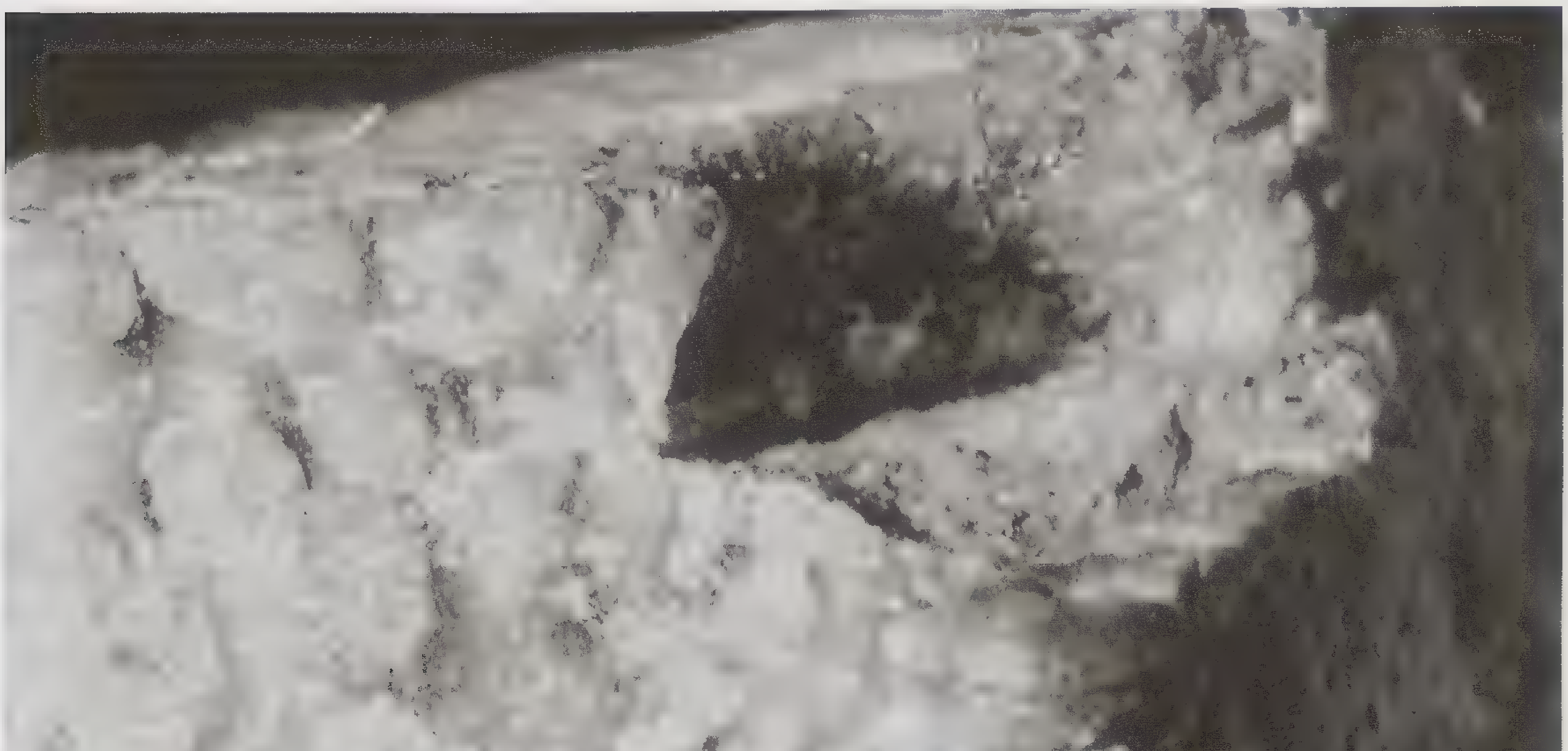


Table 5.—Measurements of *Cymbites laevigatus* (J. de C. Sowerby, 1827). All measurements are in mm.

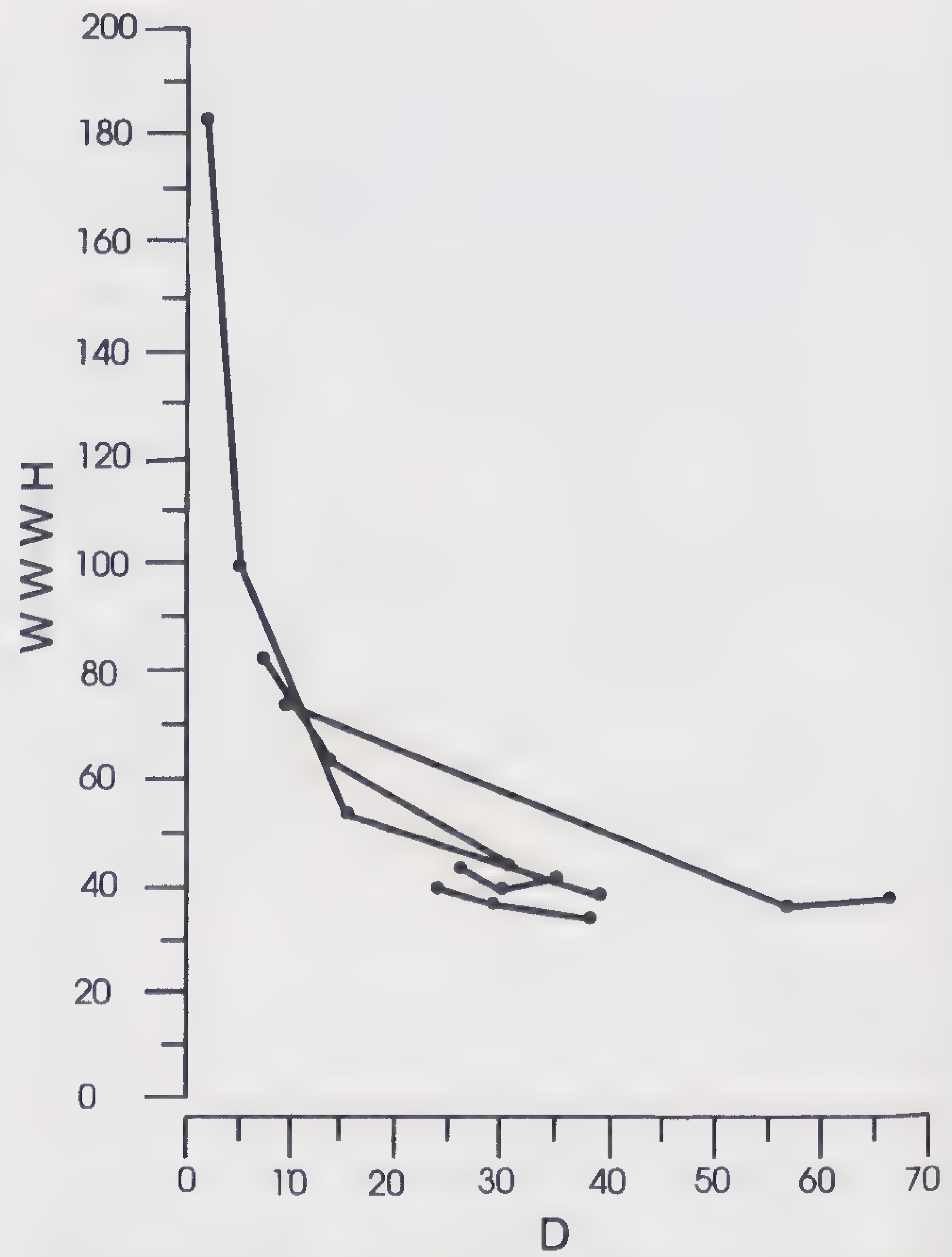
specimen no.	*DM-AX*	*D*	*UD*	*U*	*WW*	*WWD*	*WH*	*WHD*	*WW-WH*
GSC 98579	13.9	13.9	4.5	32.3	4.3	30.9	4.5	32.4	95.6
		11	2	18.2	4.2	38.1	4.3	39.1	97.7
GSC 98580	10.7	10.7	3.5	32.7	4	37.4	4	37.4	100
GSC 99018	10.5	10.5	2.5	23.8	4	38.1	4.4	41.9	90.9
MEAN				26.8		36.1		37.7	96
ST. DEV.				7		3.5		4	3.9

Remarks.—Fanninoceras has been considered a synonym of *Radstockiceras* Buckman, 1918, by Donovan and Forsey (1973), Donovan *et al.* (1981), and Meister (1986) but not by those workers who have actively studied eastern Pacific Lower Jurassic faunas (Frebold, 1967; Imlay, 1968, 1981; Hillebrandt, 1981, 1987; Smith, 1986; Smith and Tipper, 1986; Thomson and Smith, 1992). The reasons for its retention are based primarily on morphology but also on stratigraphic range.

Fanninoceras undergoes a marked change in morphology during its ontogeny (Text-figs. 27 and 28). Early whorls are depressed, with a rounded venter and commonly ornamented with either coarse or fine ribbing depending on the species. At this stage the umbilical wall is low and grades evenly into the flanks. As the ribbing disappears, the whorls become compressed with a sharp venter, an undercut umbilical wall, and an acutely angled umbilical shoulder. Frebold (1967) has pointed out that the external suture of *Fanninoceras* is wider than in *Radstockiceras* and the lateral lobe consequently occupies a position nearer the middle of the flank.

Radstockiceras is a Lower Pliensbachian genus that ranges as high as the Davoei Zone in northwest Europe. The exact age of *Fanninoceras* has long been uncertain but it is now known to be characteristic of the entire Upper Pliensbachian with the first occurrence in beds that correlate approximately with the upper Davoei Zone (Smith *et al.*, 1988) and its last occurrence (one locality) in the lowest Toarcian of Chile (Hillebrandt and Schmidt-Effing, 1981, p. 30; Hillebrandt, oral commun., 1987).

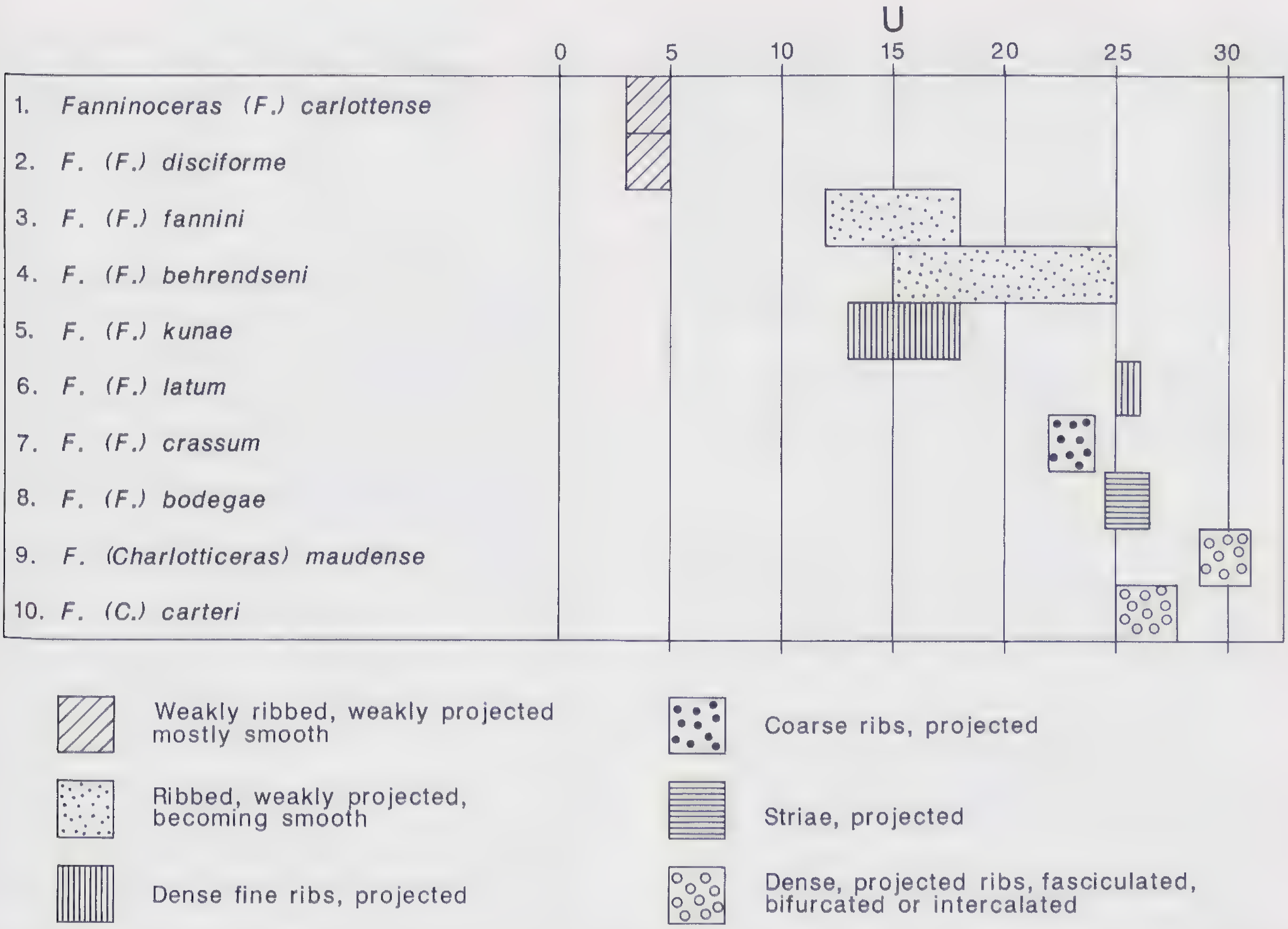
We have suggested (Smith and Tipper, 1986) that *Fanninoceras* evolved from *Radstockiceras* with its origins in a form similar to *R. gemmellaroi* (see Wiedenmayer, 1977). Hillebrandt (oral commun., 1987), however, has sequences in South America that suggest an origin within the endemic genus *Eoamaltheus*. He recently figured a specimen (of *Eoamaltheus*) from the Meridianus Zone of Argentina described as intermediate between *Eoamaltheus* and *Fanninoceras* (Hillebrandt, 1990a, fig. 4.4). It is evolute and keeled, a combination of features reminiscent of the new species described herein as *Fanninoceras* (*Charlotticeras*) *carteri* and *F.* (*Charlotticeras*) *maudense.* These two species, however, do not have the tuberculate inner whorls typical of *Eoamaltheus,* they more commonly have secondary and bifurcated ribs, and they occur stratigraphically higher than species of *Eoamaltheus.* The two species are here placed in *Fanninoceras (Charlotticeras)* but it is conceivable that they belong instead to a separate genus that had its origins within *Eoamaltheus* in the south Pacific and migrated to North America in the Late Pliensbachian.



Text-figure 28.—The ontogeny of whorl shape in *Fanninoceras (F.) fannini,* the type species of *Fanninoceras (Fanninoceras),* showing the characteristic change from depressed inner to compressed outer whorls (from Smith, 1986).

In summary, the generic features of *Fanninoceras* are the generally compressed, involute shell with an undercut umbilical wall with the shell undergoing significant morphologic changes during ontogeny. The ten species currently recognized are characterized by the combination of volution and costation as illustrated in Text-figure 29.

Age and distribution.—Fanninoceras is endemic to the eastern Pacific occurring from Chile and Argentina



Text-figure 29.—Typical combinations of volution and ornamentation for species of *Fanninoceras* at shell diameters greater than 20 mm. U is the ratio of umbilical diameter to shell diameter as a percentage. *Fanninoceras (F.) carlottense* includes *F. (F.) oxyconum*; *F. (F.) fannini* includes *F. (F.) dolmagii*; *F. (F.) kunae* includes *F. (F.) lowrii*.

in the south to southern Alaska in the north. In North America its first appearance is taken to mark the base of the Upper Pliensbachian and its range spans the Kunae and Carlottense zones (approximately equivalent to the uppermost Davoei to Spinatum Zone of the northwest European succession). The genus has not been reported from the Boreal craton faunas of the Fernie Group and the Arctic but it is widespread in the allochthonous Canadian terranes, the Blue and Wallowa Mountains (Oregon), and Sonomia (Nevada) (Smith and Tipper, 1986).

Most species of *Fanninoceras,* particularly the less involute and more strongly ribbed forms, occur in the Kunae Zone and its equivalents. The earliest species appears to be the South American *F. behrendseni* which is a large, relatively evolute form with strong ribbing in its early ontogeny; it appears to predate the Kunae Zone. The very involute, characteristically smooth forms such as *F. carlottense* and *F. disciforme* are more characteristic of the Carlottense Zone and its equivalents. *F. carlottense, F. fannini, F. kunae,* and *F. latum* are widely distributed along the eastern Pacific. *F. crassum* and *F. bodegae* are only known in North America whereas *F. behrendseni* and *F. disciforme* appear to be endemic to South America.

Table 6.—Measurements of *Fanninoceras* (*Fanninoceras*) *bodegae* McLearn, 1932. All measurements are in mm.

specimen no.	*DM-AX*	*D*	*UD*	*U*	*WW*	*WWD*	*WH*	*WHD*	*WW-WH*
GSC 6518	29.2	27.7	7.0	25.3	5.4	19.5	12.7	45.8	42.5
		19.0	5.3	27.3	4.0	21.0	8.6	45.3	46.5

Fanninoceras (Fanninoceras) bodegae
McLearn, 1932
Plate 2, figure 2

Description.—Evolute for the genus (U>25); whorls compressed. The umbilical wall is low and slightly undercut and the flanks gently convex. The striations,

Table 7.—Measurements of *Fanninoceras* (*Fanninoceras*) *carlottense* McLearn, 1930. All measurements are in mm.

specimen no.	*DMAX*	*D*	*UD*	*U*	*WW*	*WWD*	*WH*	*WHD*	*WWWH*
GSC 4878	66.5	66.5	3.5	5.3	12.3	18.5	39.6	59.6	31.1
GSC 98585	57.7	57.7	c2	c3.5	14.6	25.3	36.3	62.9	40.2
GSC 98586	c71.6	c71.6	2.5	c3.5	15	c20.9	c44	c61.5	c34.1
GSC 87807	40.8	40.8	2	4.9	10.4	25.5	24.8	60.8	41.9

which characterize the species, are visible on the upper third of the flank where they are seen to be dense and strongly projected into the venter.

Type material.—Holotype: *Fanninoceras bodegae* McLearn, 1932, p. 80, pl. 9, figs. 7–9; GSC 6518.

Material.—One specimen from the Fannin Formation.

Measurements.—See Table 6.

Discussion.—McLearn (1932) erected this species based on a single specimen that differed from all other species of *Fanninoceras* by being only moderately involute and showing striations instead of being smooth or showing costation. In terms of volution it is similar to *Fanninoceras latum* with which it could be conspecific. *F. latum* differs by having a sharper venter and ribbing which is stronger but has the same trend.

The material from Oregon identified by Imlay (1968) as *Fanninoceras* cf. *bodegae* appears to be more strongly ribbed than the type material and in many respects is similar to *Tragophylloceras* sp. described both from Oregon (Imlay, 1968) and the Queen Charlotte Islands (herein). Unfortunately a trace of the septal suture, which would settle the matter, is not available for study.

Occurrence.—Only known with certainty from the Queen Charlotte Islands; possibly present in Oregon.

Locality.—ET4.

Age.—Kunae Zone (Late Pliensbachian).

Fanninoceras (Fanninoceras) carlottense
McLearn, 1930
Plate 2, figures 3–7; Text-figures 30j, 31d

Sphenodiscus requienianus? d'Orbigny. Whiteaves, 1884, p. 248, pl. 22, fig. 4.

Fanninoceras carlottense McLearn, 1930, p. 4; 1932, p. 76; Frebold, 1967, pl. 1, fig. 1, (holotype refigured); 1970, p. 435, pl. 2, fig. 3 (holotype refigured); Blasco, Levy and Nullo, 1978, p. 425, pl. 1, fig. 4; Smith *et al.*, 1988, pl. 5, figs. 9–11.

Fanninoceras cf. *carlottense* McLearn. Imlay, 1968, p. C44, pl. 8, figs. 23, 24; 1981, p. 36 (not figured).

non *Fanninoceras* cf. *carlottense* McLearn. Hillebrandt, 1981, pl. 6, fig. 11.

Fanninoceras oxyconum Hillebrandt, 1981, p. 513, pl. 6, figs. 12–14; pl. 7, fig. 7; pl. 8, figs. 1, 2; pl. 10, figs. 9–12; Quinzio, 1987, pl. 5, fig. 1.

Fanninoceras aff. *disciforme* Hillebrandt. Pérez, 1982, pl. 18, fig. 8.

Description.—Very involute, rapidly expanding form with a compressed whorl section and an acute venter. Ornamentation is very weak consisting of broad, sometimes striate ribs that are prorsiradiate, gently flexuous on the flanks and only weakly projected onto the venter. Up to shell diameters of approximately 1 cm, the ribbing is slightly stronger and the venter more rounded than acute. At shell diameters in excess of 3 cm, the shell is usually smooth. The species reached a large size (diameters in excess of 15 cm), as suggested by many large fragments found and the fact that the holotype is completely septate. Hillebrandt (1981) figures a specimen of *F. oxyconum* (considered here a synonym of *F. carlottense*) that is completely septate at a shell diameter of 14 cm and has an expansion rate of approximately 3 suggesting a complete diameter of approximately 24 cm assuming a body chamber of half a whorl.

Type material.—Holotype: *Sphenodiscus requienianus*? d'Orbigny, Whiteaves, 1884, p. 248, pl. 22, fig. 4 by original designation (McLearn, 1930); GSC 4878.

Material.—Sixteen specimens in calcareous sandstone of the Fannin Formation.

Measurements.—See Table 7.

Discussion.—*Fanninoceras carlottense* is the most involute, the least costate, and stratigraphically the highest ranging species of *Fanninoceras* in the Queen Charlotte Islands.

Occurrence.—Reported from Argentina (Blasco *et al.*, 1978), Chile (Hillebrandt, 1981; Perez, 1982), Nevada (Smith and Tipper, 1986), Oregon (Imlay, 1968; Smith *et al.*, 1988), and Alaska (Imlay, 1981). It is characteristic of the Upper Pliensbachian, particularly the highest parts.

Localities.—B06, ET4, ET5, E63, E66, I06.

Age.—Kunae (rare) and Carlottense zones (Late Pliensbachian).

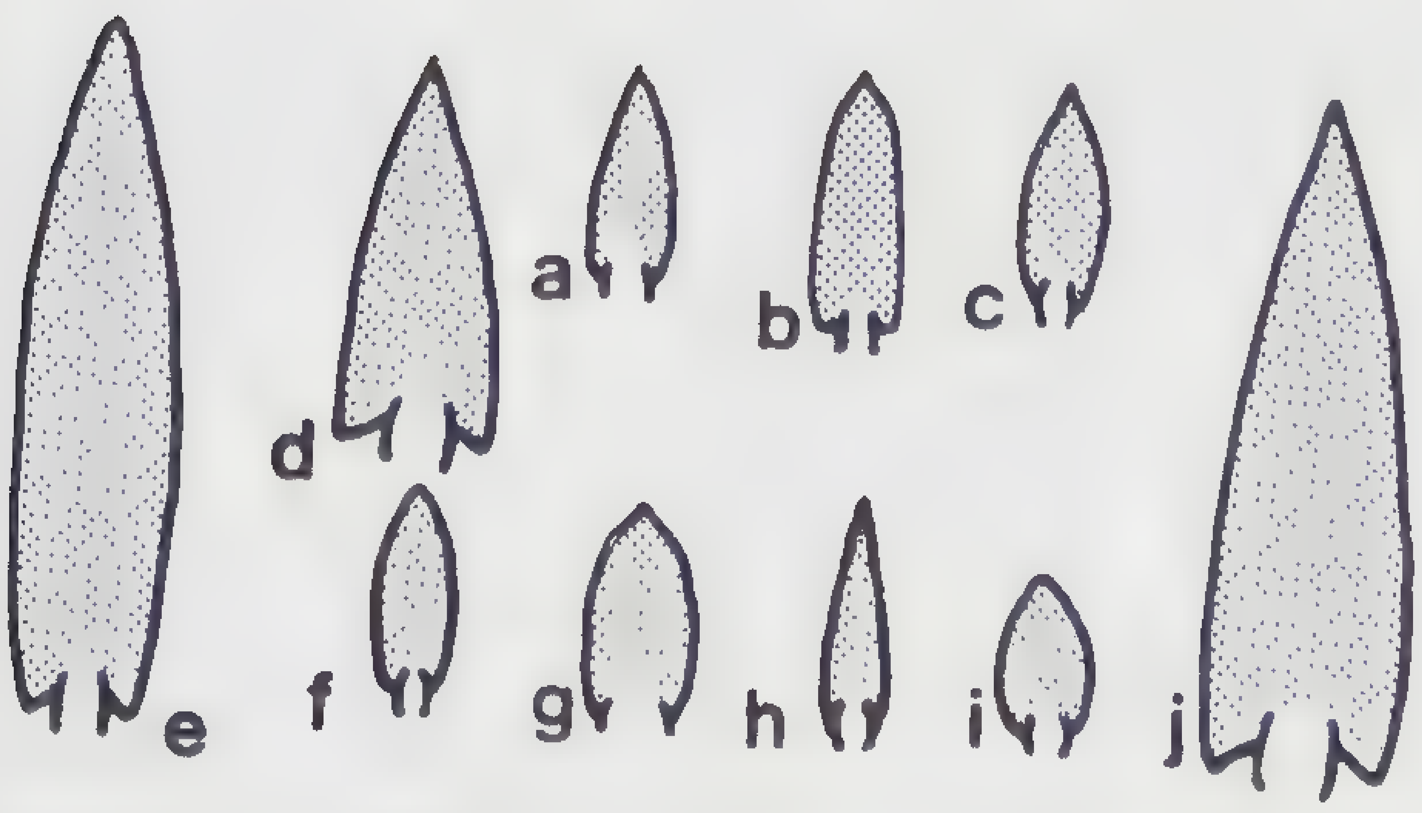
Fanninoceras (Fanninoceras) crassum
McLearn, 1932
Plate 4, figures 1–4; Text-figure 30c

Fanninoceras kunae var. *crassum* McLearn, 1932, p. 78, pl. 9, figs. 1–4; Frebold, 1964b, pl. 9, fig. 4.

Fanninoceras kunae McLearn. Imlay, 1981, p. 36, pl. 7, fig. 11.

Fanninoceras crassum McLearn. Smith, Tipper, Taylor and Guex, 1988, pl. 4, fig. 5, 6.

Description.—Rapidly expanding and evolute. The venter is rounded on the nucleus (pl. 4, fig. 3c). The



Text-figure 30.—Whorl shape cross-sections for species of *Fanninoceras.* Figures are natural size unless otherwise indicated. a-b. *Fanninoceras (Charlotticeras) maudense,* n. sp. (a. Paratype GSC 98624, b. Paratype GSC 98619)(both x1.3); c. *Fanninoceras (Fanninoceras) crassum* McLearn, 1930 (GSC 98603); d-e. *Fanninoceras (Fanninoceras) fannini* McLearn, 1930 (d. Holotype GSC 9054, e. Plesiotype GSC 6495); f. *Fanninoceras (Fanninoceras) latum* McLearn, 1930 (Type GSC 98610) (x1.3); g. *Fanninoceras (Fanninoceras) kunae* McLearn, 1930 (GSC 98607); h-i. *Fanninoceras (Charlotticeras) carteri,* n. sp. (h. Holotype GSC 98614, i.Paratype GSC 98618) (both x1.3); j. *Fanninoceras (Fanninoceras) carlottense* McLearn, 1930 (Holotype GSC 4878).

outer whorls are compressed, the umbilical wall undercut, the flanks flat and the venter sharp.

The low density ribs are coarse, rectiradiate on the flanks and projected onto the venter.

Type material.—*Fanninoceras kunae* var. *crassum* McLearn, 1932; Holotype: GSC 6496, pl. 9, figs. 1–2 (refigured herein, Pl. 4, fig. 2); Paratype: GSC 6517, pl. 9, figs. 3–4 (refigured herein, Pl. 4, fig. 1).

Material.—Five specimens in calcareous sandstone of the Fannin Formation.

Measurements.—See Table 8.

Discussion.—When McLearn (1932) established the species *F. kunae* he recognized two varieties, a coarsely ribbed form he called *F. kunae* var. *crassum* and an evolute, more finely ribbed form called *F. kunae* var. *latum.* Not only are these forms morphologically distinct with no apparent intermediates, they have different geographic distributions. McLearn's varieties are therefore raised to specific status.

F. crassum is one of the more evolute species of *Fanninoceras* (Text-fig. 29) but, as the name suggests, it is most characterized by the coarseness of its ribbing.

Occurrence.—*F. crassum* is also known from the Ashcroft area (Arthur, 1985) of southern British Columbia and the Wallowa Mountains in northeastern Oregon (Smith, 1981). The forms from east-central Oregon suggested by Imlay (1968) to be *F. crassum* have a whorl section that is far too wide and a broad, rounded venter; they probably represent a new species.

Localities.—E55, ET4, GT4.

Age.—Kunae Zone (Late Pliensbachian).

Fanninoceras (Fanninoceras) fannini
McLearn, 1930
Plate 3, figures 1–12; Plate 5, figures 1, 2;
Text-figures 27, 30d–e, 31a–c

Fanninoceras fannini McLearn, 1930, p. 4, pl. 1, fig. 3; 1932, p. 72, pl. 7, figs. 7, 8; pl. 8, figs. 1–8; Frebold, 1964b, pl. 8, figs. 1, 3, 8; pl. 9, fig. 5 (type material refigured); 1967, pl. 1, figs. 2, 3 (holotype and paratype refigured); 1970, pl. 2, fig. 5 (paratype refigured); Blasco, Levi and Nullo, 1978, p. 424, pl. 1, fig. 7; Hillebrandt, 1981, pl. 6, figs. 3–5, 8–10; Pérez, 1982, pl. 18, figs. 11–13; Smith *et al.,* 1988, pl. 4, figs. 3, 4, 7.

Fanninoceras dolmagii McLearn. McLearn, 1932, p. 75, pl. 5, figs. 4, 5; Frebold, 1967, pl. 1, fig. 5 (holotype refigured).

Fanninoceras sp. Blasco, Levy and Nullo, 1978, p. 425, pl. 1, fig. 11.

Fanninoceras cf. *carlottense* McLearn. Hillebrandt, 1981, pl. 6, fig. 11.

Description.—Early whorls are depressed with a broadly arched venter and a low, gently sloping umbilical wall. Ribs are simple, strong, prorsiradiate, and weakly projected onto the venter where they quickly fade. After shell diameters of 10 to 15 mm the whorls become compressed and the ribs broaden and become more densely spaced. As growth continues, whorl compression increases, the umbilical wall becomes marked and undercut, and the ribs disappear (Text-figs. 27 and 28).

Type material.—When the species was set up it was illustrated by an inadequate sketch of the holotype (McLearn, 1930). The holotype (GSC 9054) was properly illustrated by McLearn (1932, pl. 8, figs. 1–3) and it is refigured herein (Pl. 3, fig. 2). McLearn (1932) also designated the following plesiotypes: GSC 6493 (pl. 8, fig. 4; refigured herein, Pl. 3, fig. 6); GSC 6494 (pl. 7,

Table 8.—Measurements of *Fanninoceras* (*Fanninoceras*) *crassum* McLearn, 1932. All measurements are in mm.

specimen no.	*DMAX*	*DPHRAG*	*D*	*UD*	*U*	*WW*	*WWD*	*WH*	*WHD*	*WWWH*	*PRHW*
GSC 6517	c26	—	24	5	20.8	5.8	24.2	10.8	45	53.7	13
GSC 6496	—	—	28.3	6.7	23.8	c5.0	c17.6	13.6	48.0	c36.8	c13
		—	24.0	5.8	24.2	c4.5	c18.7	11.8	49.2	c38.1	—
GSC 98603	24.3	24.3	24.3	5.8	23.9	5.4	22.2	10.9	44.9	49.5	15
GSC 87798	22.9	c16	21.5	4.8	22.3	5.6	26.0	9.4	43.7	59.6	13
		—	18	4.3	23.9	4.9	27.2	7.9	43.9	62.0	12

Table 9.—Measurements of *Fanninoceras* (*Fanninoceras*) *fannini* McLearn, 1930. All measurements are in mm.

specimen no.	*DMAX*	*D*	*UD*	*U*	*WW*	*WWD*	*WH*	*WHD*	*WWWH*
GSC 6493	35.2+	35.2	4.7	13.3	8.7	24.7	20.3	57.8	42.9
		29.8	4.3	14.4	6.8	22.8	16.8	56.4	40.5
		25.8	4.6	17.8	6.0	23.2	13.6	52.7	44.1
GSC 6494	36.8	32.3	—	—	7.8	24.0	17.4	54.0	44.8
		14.0	3.3	23.5	4.5	32.0	7	50.0	64.3
		7.5	2.2	29.3	2.8	37.3	3.4	45.3	82.4
GSC 6495	—	66.6	7.8	11.7	14.2	21.3	36.5	54.8	38.9
		56.6	—	—	11.4	20.1	30.4	53.7	37.5
		9.4	2.8	30.0	3.6	38.2	4.8	51.0	75.0
GSC 6519[1]	34.1	34.1	6.1	17.9	7.1	20.8	18.3	53.6	38.8
GSC 9054[2]	38.5	38.5	5.2	13.5	7.3	18.9	21	54.5	34.8
		30.0	5.5	18.2	5.8	19.2	25.6	52.0	37.2
		24.2	4.8	20.0	5.0	20.6	12.3	50.8	40.7
GSC 98594	25.8	25.0	2.8	11.2	5.9	23.6	14.2	56.8	41.5
GSC 98596	12.4	12	3.0	25	3.4	28.3	4.9	40.1	69.4
GSC 98597	c52.5	51.4	6.2	12.1	12	23.3	29.5	57.4	40.7
GSC 98598	29.6	28.2	2.9	10.3	7.9	28	16.4	58.2	48.2
GSC 87799	—	—	—	—	15.7	—	39.5	—	39.7
GSC 98600	22.6	22.6	2.5	11.1	6.4	28.3	12.6	55.8	50.8

[1] Holotype of *F. dolmagii.*
[2] Holotype of *F. fannini.*

figs. 7, 8; refigured herein, Pl. 3, fig. 4); GSC 6495 (pl. 8, figs. 5–8; refigured herein, Pl. 3, fig. 1).

Material.—Approximately 65 specimens in calcareous sandstone and siltstone of the Fannin Formation.

Measurements.—See Table 9.

Discussion.—At similar shell diameters, *F. (F.) dolmagii* (holotype refigured on Pl. 3, fig. 3) is indistinguishable from *F. (F.) fannini* and the two are here considered synonyms.

In terms of volution, *F. (F.) fannini* belongs to the intermediate group of species where U=c.15 at large shell diameters. The similarly volute *F. (F.) kunae,* which also occurs in the Queen Charlotte Islands, differs by having sharper, more densely spaced ribs that project more strongly onto the venter.

Occurrence.—*F. fannini* is widely distributed in the eastern Pacific where it is most characteristic of the lower part of the Upper Pliensbachian; it is used as a zonal index in South America (Hillebrandt, 1987).

Localities.—C04, D20, ET4, ET5, E53–56, E58, E63, FT2, F07, GT4, I06, I07, I17.

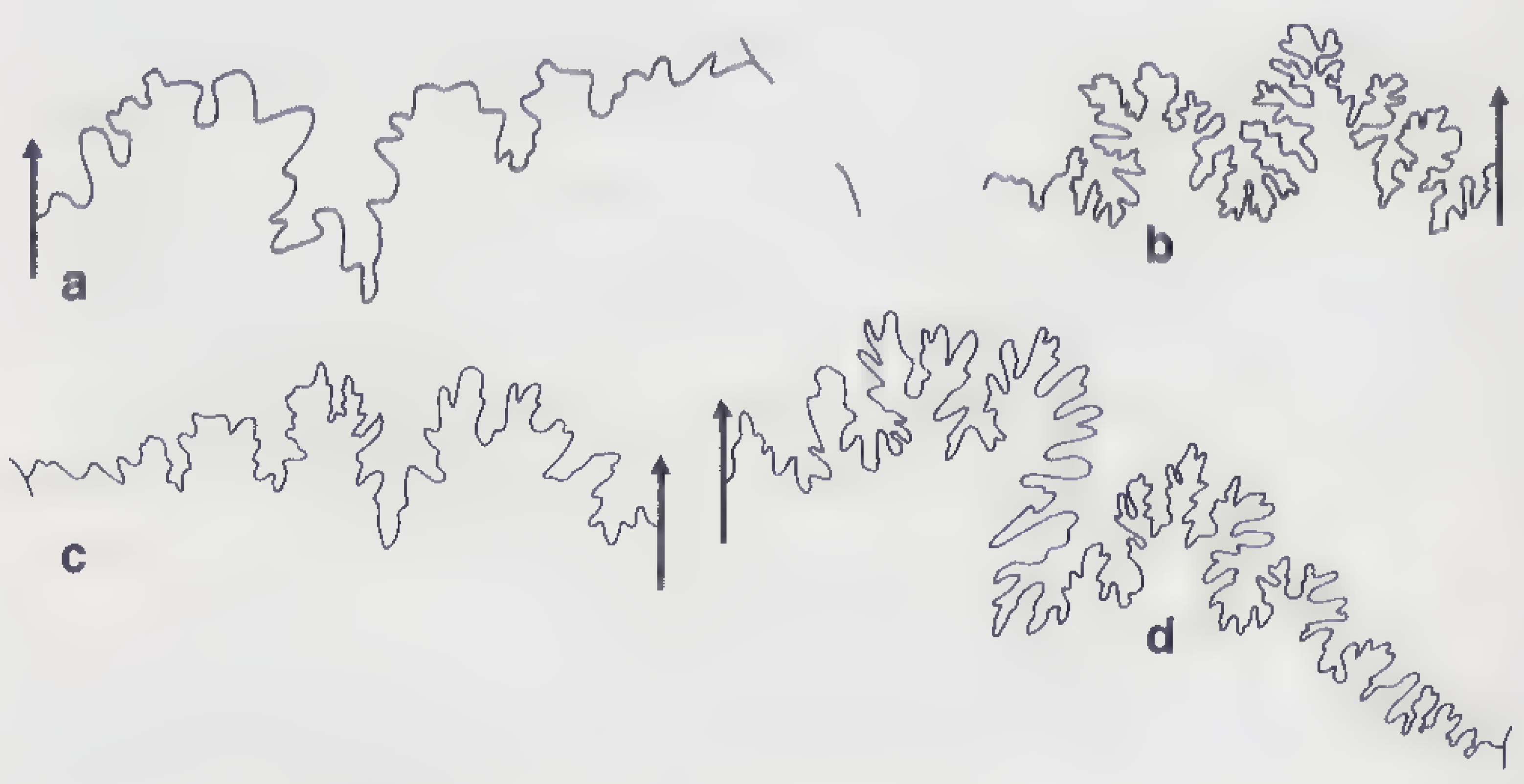
Age.—Kunae Zone and rare occurrences in the Carlottense Zone (Late Pliensbachian).

Fanninoceras (Fanninoceras) kunae
McLearn, 1930
Plate 4, figures 5–8, 11, 12; Text-figure 30g

Fanninoceras kunae McLearn, 1930, p. 5, pl. 2, fig. 4; 1932, p. 77, pl. 8, figs. 11, 12; Frebold, 1967, fig. 4 (holotype refigured); Smith, Tipper, Taylor and Guex, 1988, pl. 4, figs. 1, 2 (holotype refigured).
Fanninoceras lowrii McLearn, 1930, p. 5, pl. 1, fig. 6; 1932, p. 79, pl. 9, figs. 10, 11.
non *Fanninoceras kunae* McLearn. Imlay, 1968, p. C44, pl. 8, fig. 25–32.
non *Fanninoceras kunae* McLearn. Imlay, 1981, p. 36, pl. 7, fig. 11.
Fanninoceras cf. *lowrii* McLearn. Hillebrandt, 1981, pl. 6, figs. 15–17.
Protogrammoceras(?) or *Fanninoceras(?)* sp. Pérez, 1982, pl. 18, fig. 4.

Description.—An involute form with an undercut to vertical umbilical wall and flat flanks. The fine ribbing is flexuous and projects onto the venter.

Type material.—Holotype: GSC 4876c figured as an inadequate sketch (McLearn, 1930, pl. 2, fig. 4); properly figured by McLearn in 1932 (pl. 8, figs. 11, 12) and refigured herein (Pl. 4, fig. 6). McLearn (1932)



Text-figure 31.—Traces of the septal suture for species of *Fanninoceras* at whorl heights (WH) indicated. a-c. *Fanninoceras (Fanninoceras) fannini* McLearn, 1930 (a. GSC 98594, WH = 6.8 mm, b. Plesiotype GSC 6495, WH = 36 mm, c. Holotype GSC 9054, WH = 14.5 mm); d. *Fanninoceras (Fanninoceras) carlottense* McLearn, 1930 (Holotype GSC 4878, WH = 36.3 mm).

Table 10.—Measurements of *Fanninoceras* (*Fanninoceras*) *kunae* McLearn, 1930. All measurements are in mm.

specimen no.	*DMAX*	*D*	*UD*	*U*	*WW*	*WWD*	*WH*	*WHD*	*WWWH*	*PRHW*
GSC 4876c[1]	—	25.5	4.8	18.8	5.3	20.8	13.0	51.0	40.8	c19
GSC 6670[2]	—	33.5	5.5	16.4	8.6	25.7	17.5	52.2	49.1	c22
GSC 9055[3]	—	21.4	3.1	14.5	4.9	23.0	11.6	54.0	42.2	—
GSC 98607	27	27	c3.5	c13.0	6.8	25.2	15.7	58.1	43.3	c24
GSC 98608	22.4	22.4	3.2	14.3	—	—	13.3	59.4	—	25

[1] Holotype of *F. kunae.*
[2] Plesiotype of *F. kunae.*
[3] Holotype of *F. lowrii.*

described but did not figure a plesiotype (GSC 6670) which is figured herein (Pl. 4, fig. 5).

Material.—Ten specimens in calcareous sandstone of the Fannin Formation.

Measurements.—See Table 10.

Discussion.—*F. lowrii* is placed in synonymy with *F. kunae* because the only notable difference between the holotypes (Pl. 4, figs. 6 and 11) is that *F. lowrii* is more involute and the ribbing slightly less sharp. These differences, however, are not considered significant enough to warrant separation at the specific level as there are now specimens that are intermediate between these two forms both in volution and costation (Pl. 4, figs. 7 and 8). The species *Fanninoceras kunae* and *F. lowrii* were erected in the same publication (McLearn, 1930) but the name *F. kunae* has priority by virtue of being the first described in the text.

Occurrence.—*F. kunae,* the zonal index of the Kunae Zone, is known from the eastern Pacific where it characterizes the lower part of the Upper Pliensbachian (Smith *et al.,* 1988).

Localitites.—ET4, E55, E58, FT2, GT4, I06.

Age.—Kunae Zone (Late Pliensbachian).

Fanninoceras (Fanninoceras) latum
McLearn, 1930
Plate 4, figures 9, 10; Text-figure 30f

Fanninoceras kunae var. *latum* McLearn, 1930, p. 5, pl. 2, fig. 3; 1932, p. 78, pl. 9, figs. 5, 6.
Fanninoceras kunae latum McLearn. Hillebrandt, 1981, p. 513, pl. 6, fig. 6; pl. 10, fig. 6.
Fanninoceras sp. Pérez, 1982, pl. 20, fig. 10.
Fanninoceras cf. *kunae* McLearn. Hillebrandt, 1990a, pl. 4, fig. 1.
Fanninoceras latum McLearn. Thomson and Smith, 1992, p. 33, pl. 12, figs. 10, 11.

Description.—Evolute with a compressed whorl section, a low, slightly undercut umbilical wall, gently convex flanks and an acute venter. The ribbing is intermediate in coarseness between *Fanninoceras kunae* and *F. crassum*; it is gently prorsiradiate, slightly flexuous on the flanks and weakly projected. Sutures are not evident.

Type material.—Holotype: GSC 9058 figured as an inadequate sketch (McLearn, 1930, pl. 2, fig. 3); properly figured by McLearn in 1932 (pl. 9, figs. 5, 6) and refigured herein (Pl. 4, fig. 9).

Material.—Six specimens in calcareous sandstone of the Fannin Formation.

Measurements.—See Table 11.

Discussion.—McLearn's (1932) variety *Fanninoceras kunae* var. *latum* is here raised to species status because of its morphological differences compared to *F. kunae* as summarized in Text-figure 29; the two forms also have different geographic distributions. The outer whorls on both specimens of *F. latum* available for study appear to be egressing slightly and the ribs become slightly more projected indicating that it may represent a microconch.

Occurrence.—*F. latum* has been reported from the Pliensbachian of north-central British Columbia (Thomson and Smith, 1992) and Atacama, Chile (Hillebrandt, 1981).

Localities.—E50 and ET4.

Age.—Kunae Zone (Late Pliensbachian).

Fanninoceras (Fanninoceras) sp. 1
Plate 4, figure 13

Description.—Specimen GSC 98589 is small and incomplete but its early whorls show the characteristic

Table 11.—Measurements of *Fanninoceras* (*Fanninoceras*) *latum* McLearn, 1930. All measurements are in mm.

specimen no.	*DMAX*	*D*	*UD*	*U*	*WW*	*WWD*	*WH*	*WHD*	*WWWH*	*PRHW*
GSC 9058	24.5	24.5	6.2	25.3	5.2	21.2	10.5	42.8	49.5	18
		19.5	5.2	26.6	3.8	25.3	9.2	47.2	41.3	—
GSC 98610	18.8	18.8	5	26.6	c4.4	23.4	7.8	41.5	56.4	17

Table 12.—Measurements of *Fanninoceras* (*Fanninoceras*) sp. 2. All measurements are in mm.

specimen no.	DM-AX	D	UD	U	WW	WWD	WH	WHD	WW-WH
GSC 98613	25	25	3	12	7	28	13.5	54	51.9

ontogenetic development of *Fanninoceras* passing from a globose nucleus to a compressed stage with an undercut umbilical wall. Ribs are simple, moderately densely spaced and projected. The specimen differs from other species of *Fanninoceras* in being fairly evolute and, more significantly, in the outer non-septate whorl fragment, which has a fastigate whorl section and ribs that project onto the venter to form weak chevrons. The specimen either represents a new species or perhaps a microconch.

Material.—One specimen from the Fannin Formation.

Locality.—ET5.

Age.—Carlottense Zone (Late Pliensbachian).

Fanninoceras (Fanninoceras) sp. 2
Plate 4, figure 14

Description.—Specimen GSC 98613 is a small, completely septate specimen that is involute and compressed with a vertical umbilical wall and fairly flat flanks. It differs from other species of *Fanninoceras* in its venter which is relatively broad and blunt. Except for weak, prorsiradiate lirae visible on one part of the specimen, there is no evidence of ornamentation.

Material.—One specimen from the Fannin Formation.

Measurements.—See Table 12.

Locality.—E63.

Age.—Carlottense Zone (Late Pliensbachian).

Subgenus **CHARLOTTICERAS**, new subgenus

Type species.—*Fanninoceras (Charlotticeras) carteri,* n. sp.

Remarks.—Forms that undergo an ontogenetic change from stout inner to compressed outer whorls like other species of *Fanninoceras* but which differ in having an incipient, irregular keel and ribs divided irregularly into primaries and secondaries. It is possible that this group is derived from finely and densely ribbed forms such as *F. (F.) kunae* and *F. (F.) latum,* particularly the latter which is suitably evolute (Text-fig. 29). As discussed above, however, it is also possible that *Fanninoceras* and *Charlotticeras* had separate origins within *Eoamaltheus,* a genus endemic to the latest early Pliensbachian of South America.

Age and distribution.—This subgenus is restricted to the Kunae Zone of North America.

Table 13.—Measurements of *Fanninoceras* (*Charlotticeras*) *carteri,* new species. All measurements are in mm.

specimen no.	DMAX	D	UD	U	WH	WHD	PR-HW	SR-HW
GSC 98614	23	20	5.5	27.5	9	45	c12	c23
GSC 98615	c23.5	16	4.4	27.5	c8.5	c53.1	c14	c27
GSC 98617	–	16	4.4	27.5	7.2	45	11	18
GSH98618	–	14	3.5	25.0	6.0	42.9	c15	18

Fanninoceras (Charlotticeras) carteri,
new species
Plate 5, figures 13–15; Plate 6, figures 1–5;
Text-figure 30h–i

Description.—A midvolute form with a compressed whorl section. Until umbilical diameters of approximately 3–4 mm, the umbilical wall rounds evenly into the gently convex flanks and the venter is broadly rounded. At larger umbilical diameters the umbilical wall becomes abrupt, the flanks more flattened and the sharp venter bears a weak keel that is irregular or serrated as a result of being crossed by the ribs. Ribs are fairly sharp, irregularly fasciculated on the lower third of the flank and projected onto the venter; some intercalated ribs are evident.

Type material.—Holotype: GSC 98614 (Pl. 6, fig. 1). Paratypes: GSC 99029 (Pl. 5, fig. 13), GSC 99028 (Pl. 5, fig. 14), GSC 99026 (Pl. 5, fig. 15), GSC 98615 (Pl. 6, fig. 2), GSC 98616 (Pl. 6, fig. 3), GSC 98617 (Pl. 6, fig. 4), GSC 98618 (Pl. 6, fig. 5).

Material.—Approximately 26 specimens in calcareous sandstone of the Fannin Formation.

Measurements.—See Table 13.

Derivation of name.—This species is named in honor of Elisabeth Carter, a micropaleontologist who has made valuable contributions to our understanding of the Jurassic biostratigraphy of the Queen Charlotte Islands.

Discussion.—*Fanninoceras carteri* differs from other species of *Fanninoceras* by the fasciculation and intercalation of ribs, and the presence of a weak keel.

Occurrence.—This species is known unequivocally only from the Queen Charlotte Islands. It may also be represented in an Upper Pliensbachian ammonite assemblage from the Tulsequah area of northwestern British Columbia (Ammonite gen. et sp. indet. 1, Frebold, 1964a, p. 22, pl. 2, figs. 7–9) but the material is too poorly preserved to be confident.

Localities.—E51, E55, E57, I06, I07, I14.

Age.—Kunae Zone (Late Pliensbachian).

Fanninoceras (Charlotticeras) maudense,
new species
Plate 6, figures 6–11; Text-figure 30a–b

Table 14.—Measurements of *Fanninoceras* (*Charlotticeras*) *maudense,* new species. All measurements are in mm.

specimen no.	*DMAX*	*D*	*UD*	*U*	*WW*	*WWD*	*WH*	*WW-WH*
GSC 98619	26.3	24.5	7.0	28.6	5.0	20.4	10	50
GSC 98620	21.5	19.5	6.1	31.2	4.8	—	7.9	60.8
GSC 98622	c24	19.5	5.6	28.7	—	—	8.0	—
GSC 98623	17.5	15.8	3.7	23.4	3.8	—	7.3	52.1
GSC 98624	17.5	16.9	3.9	23.1	3.7	—	7.9	46.9

non *Fanninoceras maudense* (Whiteaves). Frebold, 1970, pl. 2, fig. 4.

Description.—The most evolute species of *Fanninoceras* yet recognized, this form possesses a smooth globose nucleus that rapidly changes its whorl shape to compressed with flat flanks and an arched venter that bears an incipient keel. The umbilical wall is low and vertical, and the umbilical shoulder is angular. Ribs are flexuous and gently prorsiradiate. They often bifurcate or are intercalated in an irregular manner forming 18 to 22 ribs per half whorl in total.

Type material.—Holotype: GSC 98620 (Pl. 6, fig. 7). Paratypes: GSC 98619 (Pl. 6, fig. 6), GSC 98621 (Pl. 6, fig. 8), GSC 98622 (Pl. 6, fig. 9), GSC 98623 (Pl. 6, fig. 10), GSC 98624 (Pl. 6, fig. 11), GSC 99029 (Pl. 5, fig. 13), GSC 99028 (Pl. 5, fig. 14), GSC 99026 (Pl. 5, fig. 15).

Material.—Thirty-four specimens in calcareous sandstone of the Fannin Formation.

Measurements.—See Table 14.

Derivation of name.—Named after Maude Island in Skidegate Inlet where some of the type material originated. The specimen *Sphenodiscus maudensis* Whiteaves, 1884 figured as *Fanninoceras maudense* (Whiteaves) by Frebold (1970, pl. 2, fig. 4) is not a *Fanninoceras* but a Cretaceous aconeceratinid (J.A. Jeletzky, written commun., 1984).

Discussion.—*F. maudense* differs from all other species of *Fanninoceras* except *F. carteri* by being more evolute, having an incipient keel and having the ribs irregularly differentiated into primaries and secondaries. *F. maudense* is slightly more evolute than *F. carteri,* its flanks flatter, the umbilical shoulder more angular and the ribs coarser.

Occurrence.—This species is only known from the Queen Charlotte Islands.

Localities.—D20, E56, E57, ET4, I06.

Age.—Kunae Zone (Late Pliensbachian).

Genus **GLEVICERAS** Buckman, 1918

Glevumites Buckman, 1918, p. 289.
Victoriceras Buckman, 1918, p. 293.
Guibaliceras Buckman, 1918, p. 293.
Tutchericeras Buckman, 1919, pl. 137A.
Riparioceras Schindewolf, 1962, p. 490.

Type species.—*Gleviceras glevense* Buckman, 1918, p. 289, by original designation. *G. glevense* is a subjective junior synonym of *G. subguibalianum* (Pia, 1914) (Bremer, 1965; Donovan and Forsey, 1973; Géczy, 1976).

Remarks.—Large forms that are closely related to *Oxynoticeras.* The venter becomes rounded with a sharp keel that is often lost on outer whorls. Whorl egression and coarsening of the ornament marks the mature state. The septal suture is complex.

Age and distribution.—Upper Sinemurian and Lower Pliensbachian of Europe, Turkey, and the east Pacific.

Gleviceras? sp.
Plate 2, figure 1

Description.—This poorly preserved, septate whorl fragment appears originally to have had a compressed whorl shape. The venter is keel-less. The simple ribs are broad and of low relief; they trend rursiradiately from the umbilical seam to the umbilical shoulder, rectiradiately across the middle of the flank and are weakly projected on the upper flank where they fade.

Material.—One fragment in sandstone of the Rennell Junction Member.

Discussion.—This specimen cannot be identified with confidence because of its poor preservation. It shows some resemblance to large coarsely ribbed species of *Gleviceras* which are most common in the Sinemurian but are known to occur as high as the Lower Pliensbachian (Géczy, 1976).

Locality.—I02.

Age.—Whiteavesi Zone (Early Pliensbachian).

Superfamily **EODEROCERATACEAE** Spath, 1929
Family **POLYMORPHITIDAE** Haug, 1887
Subfamily **POLYMORPHITINAE** Haug, 1887
Genus **GEMMELLAROCERAS** Hyatt, 1900

Tubellites Buckman, 1924, pl. 491.
Leptonotoceras Spath, 1925, p. 170.

Type species.—*Aegoceras aenigmaticum* Gemmellaro, 1884, pl. 3, figs. 12, 14, 15, by original designation (Hyatt, 1900, p. 574).

Remarks.—Small, evolute forms with a compressed whorl section and a rounded, featureless venter. Ornamentation is either subdued or the shell is smooth.

Age and distribution.—*Gemmellaroceras* has been reported most frequently from circum-Mediterranean countries where it is characteristic of the Jamesoni and Ibex zones (Géczy, 1976; Braga, Comas-Rengifo, Goy

Table 15.—Measurements of *Gammellaroceras senigmaticum* (Gemmellaro, 1884). All measurements are in mm.

specimen no.	*DMAX*	*D*	*UD*	*U*	*WW*	*WWD*	*WH*	*WHD*	*WWWH*
GSC 98631	11.0	11.0	5.2	47.3	2.6	23.6	2.6	23.6	100
GSC 98632	13.0	12.1	6.5	53.7	2.5	20.7	2.8	23.1	89.3
GSC 98630	16.0	16.0	8.0	50	3.3	20.6	4.4	27.5	75
GSC 98633	14.8	14.8	7.6	51.4	2.7	18.3	3.5	23.6	77.2
GSC 95575	c17	12.5	6.0	48	2.5	20	3.6	29	69.4
MEAN				50.1		20.6		25.4	82.2
ST. DEV.				2.6		1.9		2.7	12.3

and Rivas, 1982; Dommergues, Ferretti, Géczy and Mouterde, 1983). *Leptonotoceras* is a morphologically similar form sometimes included as a subgenus of *Gemmellaroceras.* It is more cosmopolitan in its distribution and restricted to the uppermost Sinemurian. Hillebrandt (1973a, 1981) reports *Gemmellaroceras* from the Lower Pliensbachian of Argentina, although it is not figured.

Gemmellaroceras aenigmaticum
(Gemmellaro, 1884)
Plate 6, figures 19–23; Text-figure 26e

Aegoceras aenigmaticum Gemmellaro, 1884, p. 189, pl. 3, figs. 12, 14 and 15; pl. 4, fig. 10; pl. 7, fig. 20.
Gemmellaroceras aenigmaticum (Gemmellaro). Braga, Comas-Rengifo, Goy, and Rivas, 1982, pl. 1, figs. 2, 3.
Gemmellaroceras aff. *aenigmaticum* (Gemmellaro). Dommergues, Ferretti, Géczy, and Mouterde, 1983, p. 475, pl. 1, figs. 1–12.

Description.—The largest specimen available for study is 20 mm in diameter but most are between 10 and 15 mm in diameter. The shell is very evolute and slowly expanding with a rounded whorl section that becomes more compressed with growth. The rounded venter is featureless. The shell is generally smooth with coarse, simple ribs arising irregularly at larger diameters.

Type material.—Holotype: Gemmellaro, 1884, pl. 3, figs. 12, 14, 15 (Hyatt, 1900, p. 574).

Material.—Eighteen specimens preserved in sandstone and siltstone of the Rennell Junction Member.

Measurements.—See Table 15.

Discussion.—The Canadian material consists of individuals that are small compared to the Sicilian holotype which reaches a diameter of almost 30 mm. There is no evidence that the Canadian specimens are mature and some are completely septate so that this size discrepancy is not considered significant.

Occurrence.—This is a Tethyan species reported from the Iberian Peninsula (Dommergues *et al.*, 1983; Braga *et al.*, 1982), Morocco (Dubar and Mouterde, 1978), and Italy (Gemmellaro, 1884) where it is characteristic of the Jamesoni and Ibex zones.

Localities.—B04, ET1, E43, GT3.

Age.—Whiteavesi and lowest Freboldi zones (Early Pliensbachian).

Gemmellaroceras cf. **alloplocum**
(Gemmellaro, 1884)
Plate 10, figures 5, 6

cf. *Aegoceras alloplocum* Gemmellaro, 1884, p. 187, pl. 4, figs. 17–20; pl. 7, fig. 22.

Description.—Very evolute (U=c50), slowly expanding forms that reach shell diameters of 30 to 35 mm and bear weak, simple ribs that become slightly stronger with growth. The ribs, whose densities are typically 18 to 22 ribs per half whorl, project onto the venter which is angular but apparently does not bear a keel.

Material.—Approximately 25 poorly preserved molds in siltstone and rarely, fine sandstone mostly from the Ghost Creek Formation with one occurrence in the basal Fannin Formation.

Discussion.—As far as preservation permits comparison, these forms most closely resemble *Gemmellaroceras alloplocum* whose close affinity to early forms of *Tropidoceras* such as *T. erythraeum* has been noted by Braga and Rivas (1985).

Occurrence.—*G. alloplocum* in Sicily occurs in beds that correlate approximately with the Jamesoni and Ibex zones. This species may also be present in the Hall Formation of southern British Columbia as discussed under *Miltoceras* cf. *sellae.*

Localities.—E08, E13, E14, E16, E19, G01, G03, G04.

Age.—Characteristic of the Imlayi Zone with one occurrence in the basal Whiteavesi Zone (Early Pliensbachian).

Gemmellaroceras sp.
Plate 6, figures 12–14

Description.—Extremely evolute and slowly expanding form with a slightly wider than high whorl section. There is no keel. Ribs are densely spaced, simple and coarse; they begin to project but fade quickly at the ventro-lateral shoulder leaving the venter featureless.

Table 16.—Measurements of *Polymorphites confusus* (Quenstedt, 1856). All measurements are in mm.

specimen no.	*D*	*UD*	*U*	*WW*	*WWD*	*WH*	*WHD*	*WW-WH*	*PR-HW*
GSC 98626	25.5	11.9	46.7	6.3	24.7	7.8	30.6	80.8	23
GSC 98595	17.1	8.0	46.8	5.7	33.3	6.4	37.4	89.1	17
GSC 98628	23.0	9.2	40	6.4	27.8	7.3	31.7	87.7	17
GSC 98627	21.6	10.3	47.7	5.6	25.9	6.1	28.2	91.8	21
MEAN			45.3		27.9		32	87.4	
ST. DEV.			3.6		3.8		3.9	4.7	

On two of the specimens (Plate 6, figs. 12 and 13) the ribbing fades and disappears.

Material.—Three specimens from the Rennell Junction Member.

Discussion.—The specimens are too small to make meaningful measurements and their small size makes them difficult to identify to the species level. They differ from other species of *Gemmellaroceras* by their very low expansion rate, their stout whorl section and their coarse ribs.

Locality.—FT1.

Age.—Associated with ammonites of the Freboldi Zone (Early Pliensbachian).

Genus **POLYMORPHITES** Haug, 1887

Type species.—*Ammonites polymorphus quadratus* Quenstedt 1845, pl. 4, fig. 9, by subsequent designation (Roman, 1938, p. 103).

Remarks.—Small, evolute forms with a subquadrate whorl section and simple ribs that are commonly tuberculate. Ventral features are disturbingly variable including plain, keeled, and keel-less with transverse ribbing.

Age and distribution.—*Polymorphites* is a widespread genus with most of its species occurring in northwest Europe. It is restricted to the Jamesoni Zone. The genus has been previously but only tentatively recognized in western North America and South America (Hillebrandt, 1987; Thomson and Smith, 1992).

Polymorphites confusus (Quenstedt, 1856)
Plate 6, figures 15–18; Text-figure 32c

Ammonites confusus Quenstedt, 1856, p. 127, pl. 15, figs. 8–10; 1885, p. 247, pl. 30, figs. 54–62.

Polymorphites confusus (Quenstedt). Schlegelmilch, 1976, p. 62, pl. 28, figs. 9, 10.

Polymorphites (Uptonia?) confusus (Quenstedt). Hoffmann, 1982, p. 189, pl. 19, figs. 1–5.

Description.—Evolute, slowly expanding forms with a compressed, subquadrate whorl section. The low umbilical wall rounds evenly into the gently convex flanks; the keel-less venter is gently arched but becomes flat with growth. No suture lines are visible so that the length of the body chamber is not known.

Ornamentation consists of dense, simple ribs that bear weak tubercles at the ventro-lateral shoulder. The ribs arise on the umbilical wall, trend rectiradiately to gently prorsiradiately across the flanks to the ventrolateral shoulder where they project weakly onto the venter and fade very rapidly.

Material.—Seven specimens and several whorl fragments preserved in limestone and one mold preserved in siltstone of the Ghost Creek Formation and Rennell Junction Member.

Measurements.—See Table 16.

Discussion.—These specimens differ from the inner whorls of *Dubariceras* and *Metaderoceras* with which they may be associated, in being more evolute and more slowly expanding, in having a less compressed whorl section and in having ribs that project onto the venter.

Occurrence.—This species is known from Germany (Hoffmann, 1982) and Portugal (Mouterde, 1967) where it occurs in the Jamesoni Zone.

Localities.—B04, E02, E03, E08, E17, G02, G03, G05, G09, H01.

Age.—Imlayi to lowest Freboldi Zone (Early Pliensbachian).

Subfamily **ACANTHOPLEUROCERATINAE** Arkell, 1950

Genus **ACANTHOPLEUROCERAS** Hyatt, 1900

Type species.—*Ammonites valdani* d'Orbigny, 1844, pl. 42, by subsequent designation. Hyatt (1900, p. 578) designated *Ammonites natrix* Schlotheim, 1820, as the type species but he based this on Zieten's illustration (1830, pl. 4, fig. 5) of *Ammonites natrix,* the only representation of the species available at the time. As pointed out by Quenstedt (1849) and later Jaworski (1931), who was the first to figure the holotype, Schlotheim's species is in fact an echioceratid. *Acanthopleuroceras* was therefore based on a misidentified type species. Bremer (1965, p. 185) renamed *Ammonites natrix sensu* Zieten as *Acanthopleuroceras pseudonatrix,* and this was accepted as the type species by Frebold (1970, p. 439), although Bremer had pointed out its unsuitability in this respect. The type material is lost and there is some doubt as to the accuracy of Zieten's figure so that Getty (1970) finally proposed *Ammonites binotatus* Oppel, 1862 as the type species. Getty considered *Ammonites binotatus* as the new name for *Ammonites valdani* d'Orbigny, 1844, a homonym of *Ammonites ("Turrilites") valdani* d'Orbigny, 1842. D'Orbigny's 1844 species was upheld (ICZN Opinion

Table 17.—Measurements of *Acanthopleuroceras thomsoni,* new species. All measurements are in mm.

specimen no.	*DMAX*	*D*	*UD*	*U*	*WW*	*WWD*	*WH*	*WHD*	*WWWH*	*PRHW*
GSC 98637	c37	27.6	12	43.5	8	29.0	8.6	31.2	93.0	19
		—	6	—	—	—	—	—	—	20
GSC 98639	—	—	11	—	6.3	—	7	—	90.0	19
GSC 98638	28.4	28.4	11.4	40.1	8.3	29.2	9.6	33.8	86.5	19
		—	7.2	—	—	—	—	—	—	19
GSC 98635	42	42	19.8	47.1	—	—	13.5	32.1	—	20
MEAN				43.6				32.4	89.8	
ST. DEV.				3.5				1.3	3.3	

996, 1973), however, and it now becomes the type species of *Acanthopleuroceras.*

Remarks.—The whorl section is quadrate to subquadrate and the venter bears a conspicuous blunt keel. Secondary ribs are rare but one or two rows of tubercles are common. The suture line has a trifid lateral lobe.

Age and distribution.—Cosmopolitan and restricted to the Ibex Zone and its correlatives.

Acanthopleuroceras thomsoni, new species
Plate 7, figures 1–5; Text-figure 32d,f

Paltechioceras cf. *P. harbledownense* (Crickmay). Imlay, 1981, p. 34, pl. 4, figs. 18–21 only.

Acanthopleuroceras aff. *stahli* (Oppel). Smith, Tipper, Taylor and Guex, 1988, Text-figure 1; Thomson and Smith, 1992, p. 18, pl. 5, figs. 1–4.

Description.—Evolute forms with an oval whorl section that becomes rectangular and compressed at umbilical diameters greater than approximately 10 mm. The flattened venter bears a low keel that is sometimes weakly sulcate. Ornamentation consists of densely spaced, rursiradiate ribs that swell or bear small rounded tubercles at their ventral ends. The nucleus is smooth but the ribbing, once established, maintains a density of approximately 19 or 20 ribs per half whorl throughout ontogeny. The suture line is not known.

Type material.—Holotype: GSC 9863 (Pl. 7, fig. 4). Paratypes: GSC 98635 (Pl. 7, fig. 1), GSC 98636 (Pl. 7, fig. 2), GSC 98637 (Pl. 7, fig. 3), GSC 98639 (Pl. 7, fig. 5).

Material.—Approximately 50 specimens in limestone, fine sandstone and siltstone of the Ghost Creek Formation and Rennell Junction Member.

Measurements.—See Table 17.

Derivation of name.—The species is named in honor of Mr. R. Thomson (Chevron Canada Ltd.) for his work on the Jurassic of northern British Columbia.

Discussion.—This form differs from *A. whiteavesi* with which it is commonly found and is closely related, by its denser, more rursiradiate ribbing, the presence of tubercles, and the weakly sulcate keel. It differs from *A. stahli* by its single rather than double row of tubercles. Two specimens identified as *Tropidoceras* sp. by Frebold (1970) are tentatively considered as variants of *A. thomsoni.* The first (Frebold, 1970, pl. 1, fig. 17) almost certainly belongs to *A. thomsoni* since it is identical to the holotype except for the ventral ends of the ribs which are not tuberculate or notably swollen. The second specimen (Frebold, 1970, pl. 2, fig. 16) differs from *A. thomsoni* by its more rectiradiate, more densely spaced ribs.

The inclusion of some specimens of *Paltechioceras* cf. *harbledownense* from southern Alaska identified by Imlay (1981) is based on examination of the material which shows the presence of ventral tubercles on the ribs; tubercles are unknown in the echioceratidae.

When preservation is poor, this form can superficially resemble species of *Arieticeras* seen higher in the section but the presence of tubercles on *Acanthopleuroceras thomsoni* serves as a readily distinguishable character.

Occurrence.—A species apparently endemic to the northeastern Pacific where it has been recorded from Alaska, British Columbia, Nevada and Oregon (Imlay, 1981; Smith, 1981; Thomson and Smith, 1992).

Localities.—A06, A08, A10, B04, E27, E33–37, E41, GT1, GT3, H08, H09, I01, I02, I16.

Age.—Whiteavesi Zone (Early Pliensbachian).

Acanthopleuroceras whiteavesi
Smith and Tipper, 1988
Plate 7, figures 6–10; Text-figures 26c, 32g-h

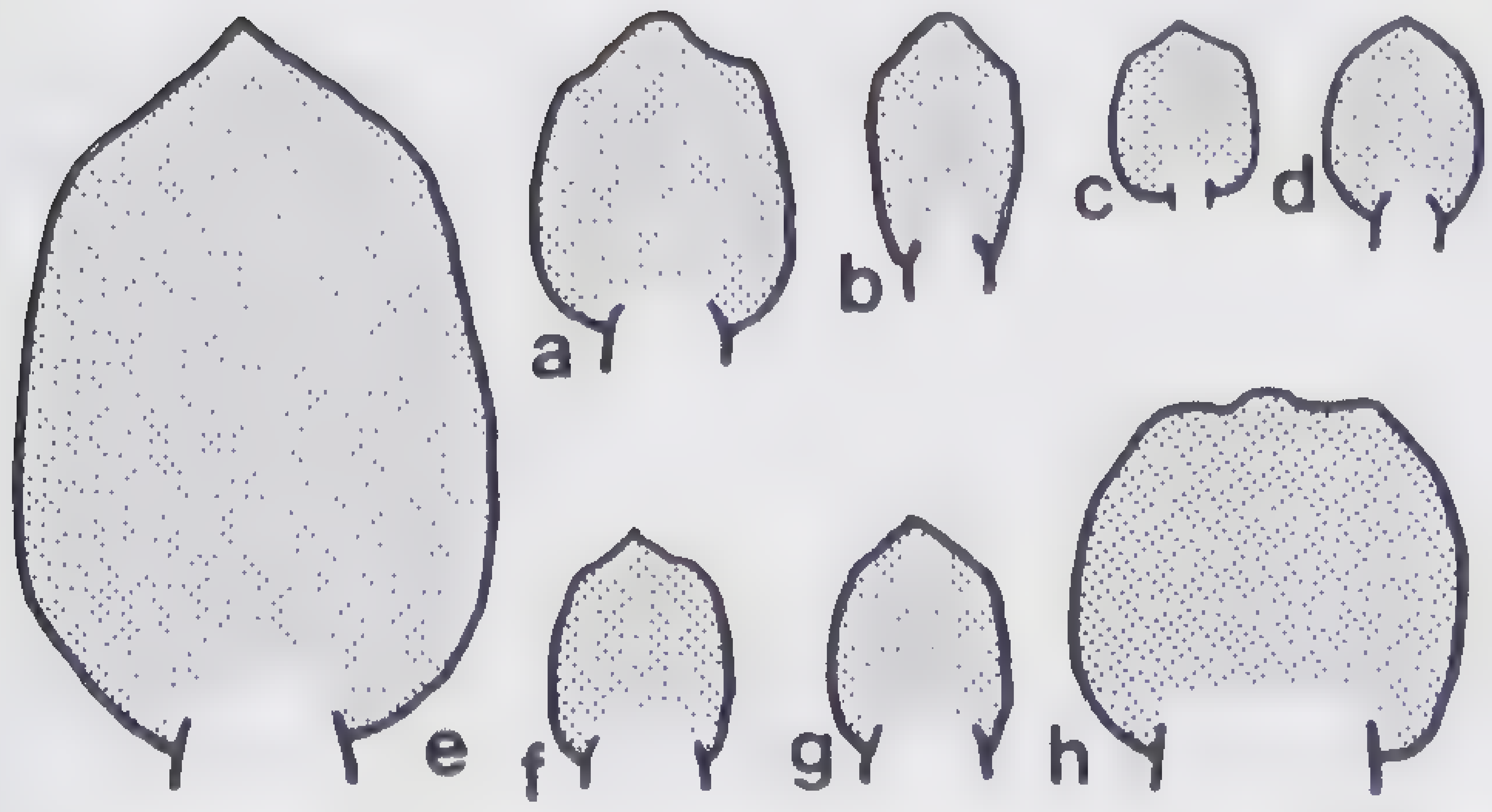
Tropidoceras actaeon (d'Orbigny). Frebold, 1970, p. 440, pl. 2, figs. 13–15.

Acanthopleuroceras whiteavesi Smith and Tipper *in* Smith, Tipper, Taylor and Guex, 1988, p. 1519, pl. 2, figs. 1–4.

Acanthopleuroceras cf. *whiteavesi* Smith and Tipper. Hillebrandt *in* Westermann, 1992, pl. 11, fig. 3a,b.

Description.—This species was erected using type material from the Queen Charlotte Islands and fully described by Smith *et al.* (1988) to which the reader is referred.

Type material.—Holotype: GSC 87790 (Smith *et al.*,



Text-figure 32.—Whorl shape cross-sections for species of the Polymorphitidae. Figures are natural size. a. *Tropidoceras* n. sp. (GSC 98648); b. *Tropidoceras actaeon* (D'Orbigny, 1844) (GSC 98645); c. *Polymorphites confusus* (Quenstedt, 1856) (GSC 98626); d,f. *Acanthopleuroceras thomsoni,* n.sp. (d. Holotype GSC 98638, f. Paratype GSC 98637); e. *Tropidoceras masseanum rotunda* (Futterer, 1893) (Holotype GSC 95573); g-h. *Acanthopleuroceras whiteavesi* Smith and Tipper, 1988 (g. GSC 98653, h. Holotype GSC 87790).

1988, pl. 2, figs. 1, 2; refigured herein, Pl. 7, fig. 7). Paratype: GSC 87791 (Smith *et al.,* pl. 2, figs. 3, 4; refigured herein, Pl. 7, fig. 6).

Material.—Forty-three specimens preserved in limestone, sandstone, and, rarely, in siltstone of the Sandilands and Ghost Creek formations and the Rennell Junction Member.

Occurrence.—This species is the zonal index for the Whiteavesi Zone to which it is restricted. Apart from the Queen Charlotte Islands, the species is also known from the Hurwal and Keller Creek formations of Oregon, information inadvertently omitted from the original species description by Smith and Tipper (*in* Smith *et al.*, 1988, p. 1521).

Localities.—A01, A02, A06, B03, C02, D02, D07, D11, ET1, E27, E34, E35, G04, I16.

Age.—Whiteavesi Zone (Early Pliensbachian).

Genus **TROPIDOCERAS** Hyatt, 1867

Type species.—*Ammonites masseanum* d'Orbigny, 1844, pl. 58, by subsequent designation (Haug, 1885, p. 606).

Remarks.—Fairly evolute forms with a compressed whorl section bearing a sharp keel. Ribbing is often weak and sometimes divided into primaries and secondaries. Species are non-tuberculate or weakly bituberculate. The suture line is complex with a bifid lateral lobe. Most workers have concluded that *Tropidoceras* and *Acanthopleuroceras* are closely related (*e.g.,* Dommergues and Mouterde, 1978, but see Wiedenmayer, 1977) and some species such as *A. stahli* and *A. rursicosta* are difficult to assign to either genus with confidence. In addition, Braga and Rivas (1985) have pointed out that *Tropidoceras* lies morphologically and chronologically between the genera *Gemmellaroceras* and *Acanthopleuroceras.*

Age and distribution.—Widely distributed but most diverse in the Jamesoni and Ibex zones of the Mediterranean region (Schlatter, 1980; Braga and Rivas, 1985).

Tropidoceras actaeon (d'Orbigny, 1844)
Plate 8, figures 1–3, 6; Text-figure 32b

Ammonites actaeon d'Orbigny, 1844, p. 232, pl. 61, figs. 1–3.
Cycloceras actaeon Futterer, 1893, p. 329, pl. 12, figs. 1, 2.
Tropidoceras aff. *actaeon* (d'Orbigny). Spath, 1928, p. 228, pl. 16, fig. 7.
Tropidoceras actaeon (d'Orbigny). Spath, 1928, p. 229, pl. 17, fig. 9; Wiedenmayer, 1980, p. 175, fig. 54a–c; Imlay, 1981, p. 37, pl. 8, figs. 1–9; Meister, 1986, p. 53, pl. 8, fig. 5.
Tropidoceras actaeon orientale (d'Orbigny). Bremer, 1965, p. 189, pl. 16, fig. 9; Text-figure 3.
non *Tropidoceras actaeon* (d'Orbigny). Frebold, 1970, p. 440, pl. 2, figs. 13–15 (=*Acanthopleuroceras whiteavesi*).
Acanthopleuroceras actaeon (d'Orbigny). Mouterde and Dommergues, 1978, fig. 25; Dommergues and Mouterde, 1978, fig. 2, no. 6; pl. 3, figs. 6–8.
Acanthopleuroceras cf. *actaeon* (d'Orbigny). Dommergues and Mouterde, 1981, p. 85, pl. 1, fig. 17.

Description.—Moderately evolute form with an oval whorl section. On early whorls the venter is angular but not sharp and there is an indistinct keel. On outer whorls, no keel is evident. Ribs are simple, not densely spaced and trend rectiradiately to gently rursiradiately towards the venter where they project weakly before quickly fading.

Type material.—Holotype: *Ammonites actaeon* d'Orbigny, 1844, pl. 61, figs. 1–3. Neotype designated and figured by Wiedenmayer, 1980, p. 175, Text-figure 54a–c.

Material.—Approximately 50 specimens mostly preserved as molds in siltstone and mudstone with a few in calcareous sandstone. Collected from the Ghost Creek Formation and Rennell Junction Member.

Measurements.—See Table 18.

Discussion.—This species is placed in *Tropidoceras* rather than *Acanthopleuroceras* because of its whorl shape and ventral features. A lectotype, which is slightly more evolute and more densely ribbed than the holotype of d'Orbigny (1844), is figured by Wiedenmayer (1980). The North American material most closely resembles d'Orbigny's holotype.

Occurrence.—*T. actaeon* is a widely distributed species characteristic of the Ibex Zone and its equivalents in Europe. In North America it is known from British Columbia and Alaska.

Localities.—A04, A05, DO3, DO5–08, D10–12, ET2, E10, E13, E18, E20–27, E30, E34, F01, GT1, GO5, G09, HO2, HO3, HO5-O7, IO2.

Table 18.—Measurements of *Tropidoceras actaeon* (d'Orbigny, 1844). All measurements are in mm.

specimen no.	*D*	*UD*	*U*	*WW*	*WWD*	*WH*	*WHD*	*WWWH*	*PRHW*
GSC 98645	48	21	44	c11.5	c0.24	15.2	31.7	c75.7	17
	–	10	–	–	–	–	–	–	15
	–	4.1	–	–	–	–	–	–	15

Age.—Upper Imlayi and Whiteavesi zones (Early Pliensbachian).

Tropidoceras cf. **erythraeum** (Gemmellaro, 1884)
Plate 10, figures 4, 7

cf. *Harpoceras erythraeum* Gemmellaro, 1884, p. 40, pl. 5, figs. 10–16.
cf. *Tropidoceras erythraeum* (Gemmellaro). Levi, 1896, p. 274, pl. 8, fig. 10; Fucini, 1896, p. 248, pl. 25, fig. 22; Bremer, 1965, p. 187, text-fig. 2c; Braga and Rivas, 1985, p. 576, pl. 1, figs. 1, 2.
Tropidoceras aff. *erythraeum* (Gemmellaro). Smith, Tipper, Taylor and Guex, 1988, pl. 1, fig. 9.

Description.—An evolute form that becomes more involute with growth. The whorl section was probably compressed and a sharp keel is evident. Early whorls are smooth or very weakly ornamented. At umbilical diameters of between 1 and 2 cm, broad, distantly spaced ribs are evident on the lower part of the flank.

Type material.—Lectotype: Gemmellaro, 1884, pl. 5, figs. 10, 11 designated by Bremer (1965, p. 187).

Material.—Twenty-five poorly preserved molds in siltstone and shale of the Ghost Creek Formation.

Occurrence.—*T. erythraeum* is the earliest occurring species of *Tropidoceras* (Jamesoni Zone). The species is circum-Mediterranean in its distribution (Turkey, Italy, Spain) and its affinities have been discussed by Braga and Rivas (1985).

Localities.—A02, EO1, EO5, EO7, E10, GO1–3, IO8–11.

Age.—Imlayi Zone (Early Pliensbachian).

Tropidoceras flandrini flandrini
(Dumortier, 1869)
Plate 9, figures 1, 2, 4

Ammonites flandrini Dumortier, 1869, p. 72, pl. 14, figs. 1, 2.
Tropidoceras flandrini (Dumortier). Fucini, 1900, p. 24, pl. 5, fig. 2; Braga and Rivas, 1985, p. 572, pl. 1, fig. 3, pl. 2, fig. 1; Meister, 1986, p. 43, pl. 8, fig. 6; Smith, Tipper, Taylor and Guex, 1988, pl. 2, fig. 6.
Tropidoceras cf. *flandrini* (Dumortier). Géczy, 1976, p. 92, pl. 17, figs. 8, 9.
Tropidoceras flandrini densicosta (Dumortier). Wiedenmayer, 1977, p. 64, pl. 14, figs. 1, 2.
Tropidoceras flandrini cf. *obtusum* (Futterer). Hillebrandt, 1987, pl. 3, figs. 4, 5.

Description.—Evolute form bearing weak ribs that become stronger, more densely spaced and bituberculate with growth. Primary ribs are fine and bear numerous fine secondary ribs that project onto the venter where a low keel is evident.

Type material.—Holotype: Dumortier, 1869, pl. 14, figs. 1, 2.

Material.—Nine specimens in dark siltstone and fine sandstone of the Ghost Creek Formation.

Measurements.—See Table 19.

Discussion.—There are three subspecies of *T. flandrini* recognized by various workers, the other two being *T. f. densicosta* (Futterer, 1893) and *T. f. obtusa* (Futterer, 1893). *T. f. densicosta* is compressed with densely spaced, weak costation; *T. f. obtusa* has a subquadrate whorl section with strong, coarser, slightly less dense costation and *T. f. flandrini* sits between these extremes. These subspecies probably reflect covariation within a single species although *T. f. densicosta* has not been recognized in the Queen Charlotte Islands collections to date.

Occurrence.—This form is common in the Mediterranean region of the Tethyan Realm as far north as southern France and southern Germany where it appears in the Jamesoni Zone and ranges into the Ibex Zone (Schlatter, 1980; Dommergues, Mouterde, and Phelps, 1984). In South America it is known from the "*Tropidoceras*" zone in Argentina (Hillebrandt, 1987).

Localities.—A08, DO4, DO7, GO3, GO4, HO4, IO8.

Age.—Imlayi and lower Whiteavesi zones (Early Pliensbachian).

Tropidoceras flandrini obtusa
(Futterer, 1893)
Plate 8, figure 5; Plate 9, figures 3, 5

Cycloceras flandrini Dumortier var. *obtusa* Futterer, 1893, p. 334, pl. 13, fig. 1.
Tropidoceras cf. *flandrini* (Dumortier). Thomson and Smith, 1992, p. 19, pl. 5, fig. 5.

Description.—Evolute form that expands fairly rapidly compared to many other species of *Tropidoceras*.

Table 19.—Measurements of *Tropidoceras flandrini flandrini* (Dumortier, 1869). All measurements are in mm.

specimen no.	*DMAX*	*D*	*UD*	*U*	*WH*	*WHD*	*PRHW*
GSC 87793	c95	80	34	42.5	27	33.8	c18
GSC 95574	64	64	27	42.2	21	32.8	18
		–	16	–	–	–	11

Table 20.—Measurements of *Tropidoceras masseanum rotunda* (Futterer, 1893). All measurements are in mm.

specimen no.	DMAX	D	UD	U	WW	WH	WHD	WW-WH	PR-HW
GSC 95573	c95	72	26.5	36.8	—	c27	37.5	—	12
		—	c20	—	14	20.4	—	68.6	11

Whorls are compressed with a low keel and, for much of ontogeny, bear only coarse, widely spaced primary ribs that are rursiradiate in trend. At umbilical diameters of approximately 35 mm, the primary ribs become strongly bituberculate with an average of four secondaries arising per primary. The secondary ribs project onto the venter.

Type material.—Holotype: Futterer, 1893, pl. 13, fig. 1.

Material.—Seven specimens in dark siltstone, only moderately well preserved. Collected from the Ghost Creek Formation.

Discussion.—This variant differs from *T. flandrini flandrini* recognized herein, by its much sparser and coarser ribbing.

Occurrence.—This form is known from the Ibex Zone of southern Germany (Schlatter, 1980) and the Whiteavesi Zone of northern British Columbia (Thomson and Smith, 1992).

Localities.—DO1, DO8, I08.

Age.—Imlayi and Whiteavesi zones (Early Pliensbachian).

Tropidoceras masseanum rotunda
(Futterer, 1893)
Plate 10, figures 1, 2; Text-figure 32c

Cycloceras masseanum d'Orbigny var. *rotunda* Futterer, 1893, p. 330, pl. 12, figs. 3, 4.
Tropidoceras masseanum (d'Orbigny) *rotunda* (Futterer). Schlatter, 1980, p. 138, pl. 19, fig. 4; pl. 20, figs. 1, 2; fig. 11, g–i.
Tropidoceras masseanum rotunda (Futterer). Meister, 1986, p. 45, pl. 6, fig. 6; pl. 7, fig. 1.

Description.—Large specimens (Pl. 10, fig. 1 is completely septate) that are moderately evolute and have a compressed whorl section bearing a low keel. The ribs are robust and tubercles are not present. The ribbing is rectiradiate to gently rursiradiate and projects onto the venter. The umbilical wall is high and rounded, the flanks weakly convex.

Type material.—Holotype: Futterer, 1893, pl. 12, figs. 3, 4.

Material.—Twenty-five specimens preserved in siltstone and calcareous concretions; mostly fragments and external molds. Collected from the Sandilands and Ghost Creek formations and Rennell Junction Member.

Table 21.—Measurements of *Tropidoceras* aff. *rursicosta* (Buckman, 1918). All measurements are in mm.

specimen no.	D	UD	U	WH	WHD	PRHW
GSC 98650	80	40	50	24	30	c14

Measurements.—See Table 20.

Discussion.—This form differs from *Tropidoceras masseanum masseanum* (d'Orbigny, 1884) by its stouter whorl section, coarser ribbing and slightly more evolute coiling.

Occurrence.—*T. m. masseanum* is widely distributed and particularly common in the Tethyan area of southern Europe. *T. masseanum rotunda* has been reported from southern Germany and southern France where it is characteristic of the lower Ibex Zone.

Localities.—A01, C02, D06–08, D10, D11, ET1, ET2, E18, E21, E23, E25, E27–31, E37, E39, GT3, G06, I02.

Age.—Whiteavesi Zone (Early Pliensbachian).

Tropidoceras aff. **rursicosta** (Buckman, 1918)
Plate 8, figure 7

aff. *Ammonites valdani* d'Orbigny. Quenstedt, 1885, p. 278, pl. 35, fig. 4.
aff. *Acanthopleuroceras rursicosta* Buckman, 1918, p. 286, pl. 26, fig. 4.
aff. *Tropidoceras rursicosta* (Buckman). Schlatter, 1980, p. 147, pl. 22, fig. 4.

Description.—Evolute, slowly expanding forms, the largest specimen of which is figured. No sutures are visible so that the length of the body chamber is unknown. The whorl section is probably subquadrate bearing a low, blunt keel. The umbilical wall is low and rounds evenly into the gently convex flanks.

There is no ribbing on the inner whorls until an umbilical diameter of 8 to 10 mm at which point broad, weak primary ribs arise that are rursiradiate and commonly swollen near the umbilicus. On larger whorls, the strength of the ribbing increases and three or four secondary ribs per primary rib project onto the venter.

Type material.—Holotype for *Tropidoceras rursicosta*: Buckman, 1918, pl. 26, fig. 4.

Material.—Four specimens, poorly preserved in mudstone and siltstone of the Ghost Creek Formation.

Measurements.—See Table 21.

Discussion.—This material represents a new species related to the large form *Tropidoceras rursicosta* which is characterized by its strongly rursiradiate, commonly tuberculate primaries and projected secondary ribs. The state of preservation of the material, however, does not warrant the establishment of a new species name.

A large specimen held in the collections of the Natural History Museum, London (number C22346) was

referred to *T. rursicosta* by Spath (1922, p. 124). It was labelled as originating from Vancouver Island (Hector collection) and included in a collection of Cretaceous age. Spath (1922) believed the specimen misplaced and suggested that it originated, like Buckman's specimen of *Acanthopleuroceras rursicosta,* from the Carixian (Lower Pliensbachian) of Gloucestershire. The possibility of it originating from the Insular Belt of British Columbia (and perhaps representing the species *T.* aff. *rursicostata* described here), however, cannot be discounted. Jurassic and Cretaceous faunas were commonly confused by early workers in this area (see Whiteaves, 1884).

Occurrence.—*T. rursicosta* is known from the Ibex Zone of Britain and the Valdani subzone of the Ibex Zone in Germany.

Localities.—E01, I08, I11, I13.

Age.—Imlayi Zone (Early Pliensbachian).

Tropidoceras new species 1
Plate 8, figure 4; Text-figure 32a

Description.—Midvolute form with a compressed whorl section. The umbilical wall is fairly high and steeply inclined, the venter angular bearing a low keel. Ribbing is coarse and rursiradiate with rounded tubercles at the ventro-lateral shoulder. The ribs weaken dramatically at the ventro-lateral shoulder and can barely be seen projecting onto the venter. No sutures are visible.

Material.—One moderately well preserved, slightly distorted internal mold and two whorl fragments preserved in sandstone of the Rennell Junction Member.

Discussion.—A somewhat similar specimen is known from southern Germany (Schlatter, 1980, p. 148, pl. 22, fig. 5) but it does not bear well marked tubercles and its inner whorls are not preserved making comparisons difficult. More material is needed before this probable new species can be properly documented.

Occurrence.—This form is only known from the Queen Charlotte Islands.

Localities.—E34, I02.

Age.—Whiteavesi Zone (Early Pliensbachian).

Tropidoceras new species 2
Plate 10, figure 3

Description.—Because of the incomplete nature of this material it is not possible to make measurements but the shell was moderately evolute with a compressed whorl section (WWWH=c63) bearing a weak keel. The umbilical wall is steep but rounds rapidly into the flattened flanks. The ribs are flexuous and strongly rursiradiate. A few ribs swell at their ventral ends and all the ribs fade as they project onto the venter where very weak striations can be seen.

Material.—Two fragments of specimens in calcareous sandstone of the Ghost Creek Formation.

Discussion.—The volution and whorl shape of these specimens are reminiscent of more finely ribbed forms of *T. masseanum* but the rursiradiate trend of the ribbing sets this material apart. It cannot be established as a new species, however, until more material is collected.

Localities.—ET1, E14.

Age.—Imlayi Zone (Early Pliensbachian).

Tropidoceras species 1
Plate 11, figures 1–3

Description.—Very evolute, slowly expanding forms with weak simple ribs that become stronger at umbilical diameters of 15 to 20 mm. A keel is evident on some of the fragments.

Material.—Nine poorly preserved molds in siltstone of the Ghost Creek Formation and Rennell Junction Member.

Discussion.—The volution and expansion rate of this form are reminiscent of those seen in *Gemmellaroceras* although the presence of a keel and, to a lesser extent, the large size of the specimens leave no doubt that it should be assigned to *Tropidoceras.* Better preserved material must be collected before a confident identification can be made.

Localities.—DO1, E18, E20, GO1, I04, I08, I11.

Age.—Imlayi and Whiteavesi zones.

Family **PHRICODOCERATIDAE** Spath, 1938

Genus **PHRICODOCERAS** Hyatt, 1900

Hemiparinodiceras Géczy, 1959, p. 143.

Type species.—*Ammonites taylori* Sowerby, 1826 (pl. 514, figs. 1, 2), by original designation (Hyatt, 1900, p. 587).

Remarks.—Early ontogenetic stages have a rounded or depressed whorl section, are strongly ribbed and bear marked lateral and paired ventral tubercles. Outer whorls are compressed with weak or obsolete ornamentation.

Age and distribution.—*Phricodoceras* is known from the Jamesoni Zone of the Northwest European Province where the rare *P. taylori* is a subzonal index (Dean *et al.*, 1961). During the course of the Pliensbachian, the genus became widely distributed, from the Mediterranean region to as far east as Roti in Indonesia (Krumbeck, 1922). Outside Northwest Europe the genus is much longer ranging (Géczy, 1976; Fantini Sestini, 1978; Dubar and Mouterde, 1978; Bremer, 1965; Dommergues and Meister, 1990) particularly in Italy where it ranges from the Raricostatum to the Margaritatus zone. The genus is not, as yet, recorded from

South America but it is previously recorded from cratonal North America by Frebold (1970).

Phricodoceras cf. **taylori**
(J. de C. Sowerby, 1826)
Plate 15, figure 2

cf. *Ammonites taylori* J. de C. Sowerby, 1826, p. 23, pl. 514, fig. 1; d'Orbigny, 1844, p. 323, pl. 103, figs. 3, 4; Quenstedt, 1856, p. 125, pl. 16, fig. 8; Hauer, 1861, p. 413, pl. 1, figs. 21–22.
cf. *Ammonites lamellosus* d'Orbigny, 1844, p. 283, pl. 84, figs. 1, 2.
cf. *Aegoceras taylori* (J. de C. Sowerby). Wright, 1880, p. 348, pl. 31, figs. 5–7; Bettoni, 1900, p. 78, pl. 8, figs. 18, 19.
cf. *Phricodoceras taylori* (J. de C. Sowerby). Del Campana, 1900, p. 587, pl. 5, figs. 45–47; Bremer, 1965, p. 175; Dommergues, 1978, p. 41, figs. 1–3.
cf. *Phricodoceras lamellosum* (d'Orbigny). Buckman, 1920, pl. 149A–D.
Phricodoceras cf. *taylori* (J. de C. Sowerby). Frebold, 1970, pl. 2, figs. 11, 12; Smith, Tipper, Taylor and Guex, 1988, pl. 1, fig. 10.
Phricodoceras cf. *lamellosum* (d'Orbigny). Dubar and Mouterde, 1978, p. 51, pl. 3, fig. 3.
Phricodoceras aff. *taylori* (J. de C. Sowerby). Dommergues and Meister, 1990, p. 299, pl. 2, fig. 3.

Description.—This specimen had an estimated diameter of 40 mm and was midvolute with U at approximately 35–40 mm. The umbilical wall rounds evenly into the rounded flanks. Ribbing is fairly dense (PRHW=13 at UD=15 mm). The ribs are simple, gently prorsiradiate and sharper on the inner whorls. Two rows of tubercles are present, one on the upper third of the flank, the other on the lateral part of the venter. The venter itself is not visible.

Type material.—Holotype: J. de C. Sowerby, 1826, pl. 514, fig. 1.

Material.—One moderately well preserved external mold in siltstone of the Ghost Creek Formation.

Discussion.—As far as preservation permits comparison, this specimen is similar to *P. lamellosum* which is common in circum-Mediterranean countries. This species has been synonymized with *P. taylori* by Bremer (1965), Wiedenmayer (1977), and Dommergues (1978). Dommergues considers the two species to be sexual dimorphs.

Occurrence.—*P. taylori* is cosmopolitan and characteristic of the Raricostatum in the Sinemurian to as high as the Ibex zone in the Pliensbachian (Dommergues and Meister, 1990; Fantini Sestini, 1978).

Locality.—I08.

Age.—Imlayi Zone (Early Pliensbachian).

Family **EODEROCERATIDAE** Spath, 1929

Genus **PSEUDOSKIRROCERAS**
Wiedenmayer, 1980

Type species.—*Coeloceras mastodon* Fucini, 1935, p. 166, pl. 40, figs. 3, 4, by original designation (Wiedenmayer, 1980, p. 172).

Remarks.—Evolute, slowly expanding forms that can reach large shell diameters. The whorl section is compressed elliptical to rounded, and a row of tubercles is present, usually in the middle of the flank. Uniform secondary ribbing bifurcates from the tubercles and is sometimes accompanied by intercalated ribs. Wiedenmayer (1980) has noted that this genus which, as the name indicates, is a homeomorph of the Bajocian *Skirroceras,* is closely related to *Miltoceras.*

Age and distribution.—A Tethyan genus that Wiedenmayer (1980) states is characteristic of the Davoei and Margaritatus zones in Europe. It also occurs in the Upper Sinemurian or basal Pliensbachian of Chile (Hillebrandt, 1981) and the lowest Pliensbachian of North America (Smith *et al.*, 1988).

Pseudoskirroceras imlayi Smith and Tipper, 1988
Plate 13, figures 1–4; Plate 14, figures 1–4;
Plate 15, figure 1

Description.—Large, evolute forms with a slightly compressed whorl section and a gently rounded venter. Primary ribs are strong and prorsiradiate, bearing tubercles just above the middle of the flank. Weaker secondary ribs arise in pairs or threes from the tubercles; some intercalated ribs are present. Within the sample there is some variability shown in the strength of the ornamentation but at shell diameters of approximately 100 mm, ribbing weakens and the tubercles fade or disappear for approximately one half whorl followed by two or three coarse ribs (Pl. 13, fig. 2; Pl. 14, fig. 4).

Type material.—*Pseudoskirroceras imlayi* Smith and Tipper *in* Smith *et al.*, 1988, p. 1519, pl. 1, figs. 1–5; Holotype: GSC 87783; Paratypes: GSC 87784, 87785.

Material.—Approximately 135 molds and fragments preserved in mudstone and siltstone of the Ghost Creek Formation.

Discussion.—A full discussion of this species was given by Smith and Tipper (*in* Smith *et al.*, 1988). This species was included in *Pseudoskirroceras* rather than the closely related *Miltoceras* on grounds of: (i) its evolute, slowly expanding shell bearing regularly spaced ribs and tubercles, and (ii) its stratigraphic position which falls within the range of *Pseudoskirroceras* as known from elsewhere in the world. It should be noted, however, that the occurrence of *Pseudoskirroceras* and *Miltoceras* low in the Pliensbachian appears to be characteristic of the Americas. The ranges of the two genera in the Mediterranean area, where they are uncommon, overlap at a higher stratigraphic level within the Pliensbachian (Davoei Zone). Further work is required to finely document this difference and to explore its phylogenetic and biogeographic implications.

Occurrence.—This species is characteristic of the

Imlayi Zone of western North America (Smith *et al.*, 1988).

Localities.—BT1, B01, B02, C01, ET1, E04, E07, E09, E16, G01–03, I08–11.

Age.—Imlayi Zone (Early Pliensbachian).

Genus MILTOCERAS Wiedenmayer, 1980

Type species.—*Aegoceras sellae* Gemmellaro, 1884, p. 179, pl. 3, figs. 1–5 by original designation (Wiedenmayer, 1980, p. 172).

Remarks.—*Miltoceras* was created as a subgenus of *Apoderoceras* by Wiedenmayer (1980) and elevated to generic status by Hillebrandt (1981). It is characterized by coronate early whorls that quickly become compressed with subparallel flanks and an arched venter. The ribbing, which is often irregular, is characterized by dense prorsiradiate primary ribs with secondary ribs arising from tubercles on the upper half of the flank. The genus is similar to *Pseudoskirroceras* which differs by being more evolute, more slowly expanding and having more regular ribbing.

Age and distribution.—A Tethyan genus ranging from the Jamesoni to the Davoei zones (Wiedenmayer, 1980). In Chile and Argentina it is known from lowest Pliensbachian rocks (Riccardi, 1984; Hillebrandt, 1987, 1990b) and in rocks of the same age in northern British Columbia (Thomson and Smith, 1992).

Miltoceras aff. **sellae** (Gemmellaro, 1884)
Plate 11, figures 4–6

aff. *Aegoceras sellae* Gemmellaro, 1884, p. 179, pl. 3, figs. 1–5.
non *Coeloceras Sellae* (Gemmellaro). Monestier, 1934, p. 101, pl. 4, figs. 6, 7, 19, 20.
Apoderoceras (Miltoceras) cf. *sellae* (Gemmellaro). Hillebrandt, 1987, pl. 1, figs. 12–14; Hillebrandt *in* Westermann, 1992, pl. 11, fig. 1.

Description.—Moderately evolute form with a compressed whorl section and an arched, keel-less venter. The prorsiradiate primary ribs are gently flexuous and bear, sometimes at irregular intervals, small tubercles a little over half way to two thirds of the way up the flank. From the row of tubercles, two or three secondaries arise per primary mostly by intercalation, and flex forward onto the venter. Ribs become coarser and less densely spaced with growth. No septal suture lines can be seen and the material is too poorly preserved to make meaningful measurements.

Type material.—Lectotype of *Miltoceras sellae*: Gemmellaro, 1884, pl. 3, figs. 1–2 (designated herein).

Material.—Seventeen poorly preserved specimens in siltstone of the Ghost Creek Formation.

Discussion.—As far as preservation permits comparison, this material is identical to material from Chile described by Hillebrandt (1981, 1987) as *Apoderoceras (Miltoceras)* cf. *sellae*. It differs from this species mainly in its less regular tuberculation.

Occurrence.—In the Mediterranean area, this species and its varieties (Wiedenmayer, 1980) occur in beds that correlate approximately with the Jamesoni and Ibex zones (Gemmellaro, 1884; Rosenberg, 1909; Fucini, 1935; Du Dresnay, 1963). In South America, it occurs in the zone of "*Apoderoceras* and *Eoderoceras*" which marks the base of the Pliensbachian (Hillebrandt, 1987). This species might also be present in the Hall Formation of the Rossland area, southern British Columbia, amongst a poorly preserved fauna initially thought to be post-middle Bajocian in age (Frebold and Little, 1962) but subsequently assigned to the Pliensbachian by Tipper (1984). Amongst the forms initially assigned in that publication to *Perisphinctes?* appear to be *Miltoceras* cf. *sellae* (Frebold and Little, 1962, pl. 4, figs. 1, 3 and 4); *Metaderoceras* sp. (Frebold and Little, 1962, pl. 4, fig. 2); and *Gemmellaroceras* cf. *alloplocum* (Frebold and Little, 1962, pl. 4, fig. 5).

Localities.—BT1, CT1, ET1, E09, E11–14, G01-G03.

Age.—Imlayi Zone (Early Pliensbachian).

Genus DUBARICERAS
Dommergues, Mouterde, and Rivas, 1984

Type species.—*Dubariceras dubari* Dommergues, Mouterde, and Rivas (1984, p. 382, pl. 1).

Remarks.—The characteristics of this genus and the taxonomic problems resulting from its convergence with certain polymorphitids have been discussed by Dommergues *et al.* (1984) and Thomson and Smith (1992). *Dubariceras* is thought to have evolved from *Metaderoceras*.

Age and distribution.—*Dubariceras* is characteristic of the western Mediterranean and the eastern Pacific. In Europe it is characteristic of beds correlative with the Ibex and Davoei zones; in North America it occurs in the Whiteavesi and Freboldi zones.

Dubariceras freboldi
Dommergues, Mouterde, and Rivas, 1984
Plate 16, figures 1, 2; Text-figure 33e

Uptonia dayiceroides Mouterde. Frebold, 1970, p. 438, pl. 1, fig. 9.
Uptonia cf. *U. dayiceroides* Mouterde. Imlay, 1981, p. 36, pl. 9, figs. 1–4, 8, 12–16.
Uptonia cf. *U. angusta* (Oppel). Hillebrandt, 1981, p. 509, pl. 5, fig. 3.
Dayiceras dayiceroides (Mouterde). Smith, 1983, p. 86, fig. 2a–c.
Dubariceras freboldi Dommergues, Mouterde, and Rivas, 1984, fig. 3–A3; Smith, Tipper, Taylor and Guex, 1988, pl. 3, figs. 1–3; Thomson and Smith, 1992, p. 27, pl. 11, figs. 1–7.
Dayiceras? sp. Hillebrandt, 1987, pl. 2, figs. 11, 12.
Dubariceras cf. *freboldi* Dommergues, Mouterde, and Rivas. Hillebrandt, 1990a, fig. 4.10, ?4.11.

Description.—Evolute with a compressed whorl section and a flat to gently arched venter that has no keel. The umbilical wall is low and steep, the umbilical shoulder abruptly rounded, the flanks flat and the ventro-lateral shoulder abruptly rounded.

Ribs are densely spaced, rursiradiate on the umbilical wall, and rectiradiate to gently prorsiradiate on the flanks. Ribs terminate at the ventro-lateral shoulder with small, elongate tubercles.

Type material.—Holotype: Frebold, 1970, pl. 1, fig. 9.

Material.—Approximately 190 specimens, many of them fragments, preserved in siltstone and calcareous sandstone. Primarily from the Rennell Junction Member of the Fannin Formation with some occurrences in the Fannin sandstone and rare occurrences in the Ghost Creek Formation.

Discussion.—Full descriptions and discussions of the taxonomic position of this widespread and biostratigraphically useful species have been published by Frebold (1970), Imlay (1981), Smith (1983), Thomson and Smith (1992), and Dommergues *et al.* (1984).

Occurrence.—*D. freboldi* is endemic to the eastern Pacific where it occurs from Argentina and Chile in the south (Hillebrandt, 1981, 1990) as far north as southern Alaska (Imlay, 1981). In South America the species occurs in the Meridianus Zone, in North America in the Freboldi Zone, intervals that correlate in part with the Ibex and Davoei zones of the Northwest European zonation. There is one locality in the Queen Charlotte Islands (F06) where the uppermost part of the range of *Dubariceras freboldi* overlaps with the lowermost part of the range of *Fanninoceras* sp. so that the two forms occur in the same bed. These genera are normally mutually exclusive and a total of only three such overlapping occurrences is known in North America (Smith *et al.,* 1988). At all three of these localities (F06 in the Queen Charlotte Islands; the Taseko Lakes area, British Columbia; the Hurwal Formation, northwestern Oregon) *D. freboldi* is common or abundant and *Fanninoceras* (*F. fannini* and *F.* sp.) is rare and condensing cannot be ruled out. *D. freboldi* will only be considered as ranging into the Kunae Zone when there is significant stratigraphic overlap demonstrated between *D. freboldi* and an assemblage of *Fanninoceras* spp. and hildoceratids which normally characterizes the Kunae Zone.

Localities.—A12, A13, C03, D13–15, D18, ET1, ET3, E42–49, FT1, F05, F06, GT2, GT3, G10, G11, I01, I07, I15.

Age.—Freboldi Zone (Early Pliensbachian).

Dubariceras silviesi (Hertlein, 1925)
Plate 15, figures 3, 4

Uptonia silviesi Hertlein, 1925, p. 39, pl. 3, figs. 1, 2, 5.
Crucilobiceras cf. *C. submuticum* (Oppel). Imlay, 1981, p. 33, pl. 7, figs. 1–3.
Uptonia cf. *U. obsoleta* (Simpson). Hillebrandt, 1981, p. 509, pl. 5, figs. 1, 2, 5; 1987, pl. 2, figs. 1, 5.
Dubariceras silviesi (Hertlein). Smith, Tipper, Taylor and Guex, 1988, pl. 2, fig. 5; Smith and Tipper, 1988, pl. 1, fig. 6; Thomson and Smith, 1992, p. 29, pl. 10, fig. 2–5.
Dubariceras cf. *silviesi* (Hertlein). Hillebrandt, *in* Westermann, 1992, pl. 11, fig. 5.

Description.—Evolute shell with a subrectangular whorl section. Ribs are simple, straight to slightly sinuous, and prorsiradiate; they terminate at the ventro-lateral shoulder in prominent tubercles. The venter is featureless except at large shell diameters where the ribs project onto the venter to form chevrons.

Type material.—Holotype: Hertlein, 1925, pl. 3, figs. 1, 2, 5.

Material.—Seventeen specimens in siltstone and calcareous sandstone of the Ghost Creek Formation and Rennell Junction Member.

Discussion.—The holotype of this species from Oregon reaches a large size (whorl height in excess of 45 mm) and comparable sizes are reached in the Queen Charlotte Islands although only whorl fragments have been collected. The species appears to have affinities with both *Metaderoceras* and *Dubariceras* as discussed by Thomson and Smith (1992). It differs from *D. freboldi* which ranges stratigraphically higher, by its less dense ribbing.

Occurrence.—*D. silviesi* is restricted to the eastern Pacific where it is characteristic of the Whiteavesi and lower Freboldi zones in North America (Smith *et al.*, 1988) and the Meridianus Zone in South America (Hillebrandt, 1987, 1990) which correlate approximately with parts of the Ibex and Davoei zones of the European zonation.

Localities.—B04, E40, FT1, GT1, GT3, I01, I02, I07.

Age.—Whiteavesi and Freboldi zones (Early Pliensbachian).

Genus **METADEROCERAS** Spath, 1925

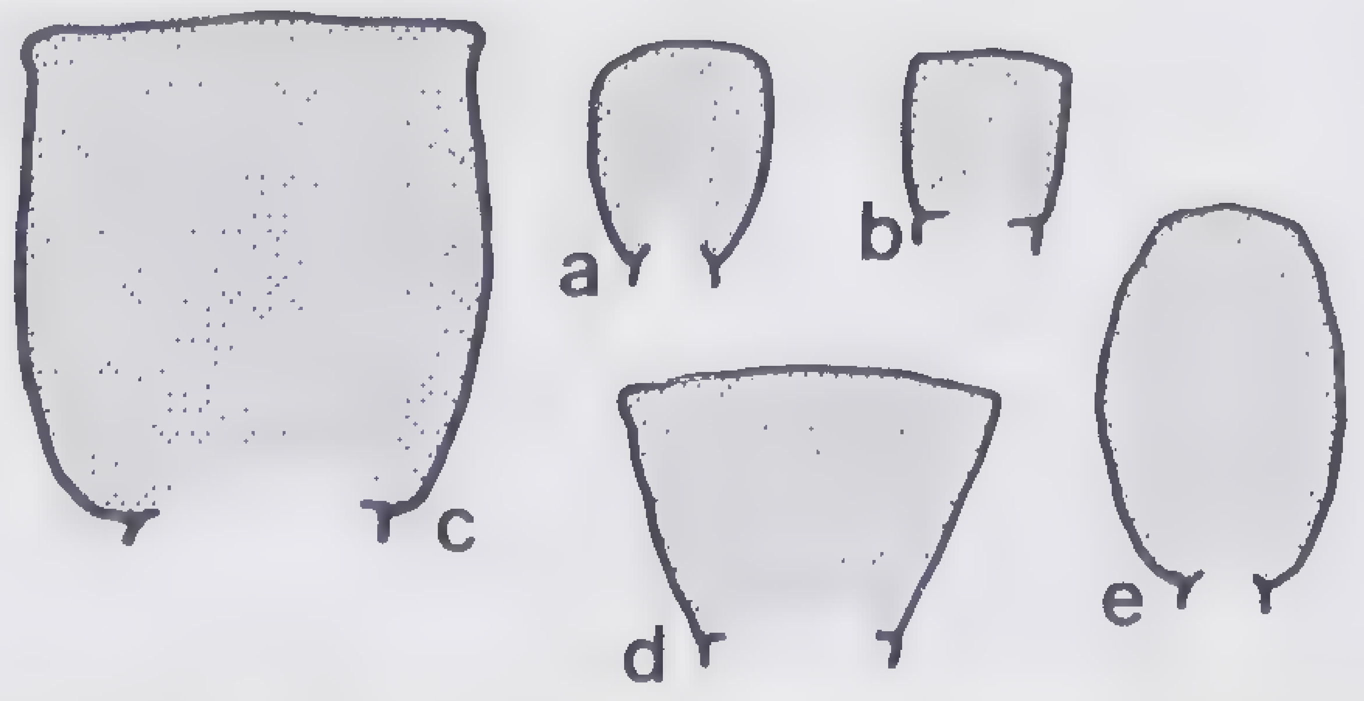
Type species.—*Ammonites muticus* d'Orbigny, 1844, p. 274, pl. 8, by original designation (Spath, 1925, p. 363).

Remarks.—Problems concerning the interpretation of this genus and the related genera *Crucilobiceras* and *Eoderoceras* are discussed by Thomson and Smith (1992).

Age and distribution.—*Metaderoceras* is widely distributed in the circum-Mediterranean region and the eastern Pacific. It occurs in the Jamesoni and Ibex zone equivalents in Europe and in the Imlayi to basal Kunae zone in western North America (Cólera *et al.*, 1978; Mouterde, 1970; Rivas, 1983; Smith *et al.*, 1988). In

South America it is reported from the Meridianus Zone which correlates in part with the Ibex and Davoei standard zones (Hillebrandt, 1981, 1987, 1990).

Metaderoceras evolutum is the earliest species of *Metaderoceras* in the Queen Charlotte Islands. In the Whiteavesi Zone it is joined by several other species of *Metaderoceras* which are generally more coarsely and more densely ribbed and which may have given rise to *Dubariceras*. This coarse ribbed group also includes the stout-whorled, strongly tuberculate *M. mouterdei* and related forms which are reminiscent of the circum-Mediterranean *M. venarense* group that Dommergues and Mouterde (1982) interpret to be the root-stock of the Dactylioceratidae in the Ibex Zone.



Text-figure 33.—Whorl shape cross-sections for species of the Eoderoceratidae. Figures are natural size. a. *Metaderoceras talkeetnaense* Thomson and Smith, 1992 (GSC 98703); b. *Metaderoceras evolutum* (Fucini, 1921) (GSC 95576); c. *Metaderoceras* sp. (GSC 98702); d. *Metaderoceras*? aff. *mouterdei* (Frebold, 1970) (GSC 87797); e. *Dubariceras freboldi* (Dommergues et al., 1984) (GSC 98686).

Metaderoceras evolutum (Fucini, 1924)
Plate 16, figures 3–5, 7; Plate 18, figure 1;
Text-figures 33b, 34a

Deroceras evolutum Fucini, 1924, p. 50, pl. 5, fig. 14.
Crucilobiceras aff. *evolutum* (Fucini). Du Dresnay, 1963, p. 147, pl. 2, figs. 2, 3.
Crucilobiceras pacificum Frebold, 1970, p. 435, pl. 1, figs. 4–8.
Crucilobiceras evolutum brutum Wiedenmayer, 1977, p. 59, pl. 13, figs. 1, 2.
Crucilobiceras evolutum evolutum (Fucini). Wiedenmayer, 1977, p. 59, pl. 13, fig. 3; 1980, p. 48, pl. 1, figs. 3, 4.
Metaderoceras evolutum (Fucini). Dubar and Mouterde, 1978, p. 44, pl. 2, fig. 1; Rivas, 1983, p. 395, pl. 1, figs. 1–8; Smith, Tipper, Taylor and Guex, 1988, pl. 1, fig. 11; Thomson and Smith, 1992, p. 22, pl. 9, figs. 5–6.
Metaderoceras evolutum brutum (Fucini). Colera, Rivas, Sequeiros and Valenzuela, 1978, p. 311, pl. 1, figs. 3, 4.
Crucilobiceras cf. *pacificum* Frebold. Imlay, 1981, p. 35, pl. 8, figs. 10–12, 15–17.

Description.—Shell evolute and slowly expanding. Whorl section usually compressed, subquadrate with a low umbilical wall, weakly convex flanks and a slightly convex or flat venter.

Ribs are rectiradiate to gently prorsiradiate and of low relief compared to other species of *Metaderoceras*. Two or three ribs merge into a large tubercle which is the base of a long spine. At large shell diameters (Pl. 18, fig. 1), ribs tend to become weakly rursiradate and terminate in individual spines rather than merging. Fine, irregular, radial lirae are evident throughout ontogeny.

Type material.—Holotype: Fucini, 1924, pl. 5, fig. 14.

Material.—Seventy-three specimens in siltstone and calcareous sandstone of the Ghost Creek Formation and Rennell Junction Member.

Discussion.—This variable species is discussed by Rivas (1983) and Thomson and Smith (1992).

Occurrence.—*M. evolutum* is common in the circum-Mediterranean region and western North America (Wiedenmayer, 1980; Rivas, 1983; Thomson and Smith, 1992).

Localities.—A03, A05, BT1, D03, D05, D07–D10, ET1, ET3, E06, E15, E25, E27, E30, GT1, G06, I08, I16.

Age.—Imlayi and Whiteavesi zones (Early Pliensbachian).

Metaderoceras mouterdei (Frebold, 1970)
Plate 19, figure 3

Crucilobiceras mouterdei Frebold, 1970, p. 437, pl. 1, fig. 2.
non *Metaderoceras mouterdei* (Frebold). Smith, Tipper, Taylor, and Guex, 1988, pl. 3, figs. 9, 10; Smith and Tipper, 1988, pl. 1, fig. 8 (see *M.?* aff. *mouterdei*).

Description.—An evolute, slowly expanding form with flanks that diverge weakly towards the slightly arched venter. Ribs are simple, gently prorsiradiate and terminate at the ventro-lateral shoulder in stout tubercles. The venter is unornamented. Rib frequency decreases with growth up to umbilical diameters of 25–30 mm.

Type material.—Holotype: Frebold, 1970, pl. 1, fig. 2; GSC 20337.

Material.—Eight specimens in sandstone of the Rennell Junction Member.

Discussion.—*M. mouterdei* is similar to *M. venarense* (Oppel), one of the highest ranging (Ibex Zone) species of *Metaderoceras* in southern Europe (Frebold, 1970; Dommergues and Mouterde, 1982). It differs, however, in its slightly narrower whorl section and in its ribbing which changes style and frequency during ontogeny.

Occurrence.—*M. mouterdei* is restricted to the Whiteavesi Zone of British Columbia. The similar *M. venarense* is known from the Ibex Zone of the Tethyan area particularly southern France and Portugal (Mouterde, 1970; Meister, 1986).

Localities.—ET1, E40, F02, GT3, G09, I02.

Age.—Whiteavesi Zone (Early Pliensbachian).

Metaderoceras? aff. mouterdei (Frebold, 1970)
Plate 16, figure 6; Plate 19, figure 4;
Text-figures 33d, 34b

aff. *Crucilobiceras mouterdei* Frebold, 1970, p. 437, pl. 1, fig. 2.
Apoderoceras cf. *A. subtriangulare* (Young and Bird). Imlay, 1981, p. 35, pl. 8, figs. 14, 18–23.
Metaderoceras mouterdei (Frebold). Smith, Tipper, Taylor, and Guex, 1988, pl. 3, figs. 9, 10; Smith and Tipper, 1988, pl. 1, fig. 8.
Metaderoceras cf. *M. mouterdei* (Frebold). Thomson and Smith, 1992, p. 23, pl. 9, figs. 1–4; pl. 10, fig. 1.

Description.—Evolute forms with whorl flanks diverging towards the venter which is characteristically broad. The innermost whorls are densely ribbed but the decrease in frequency and coarsening of the ribbing is typically underway at umbilical diameters less than 10 mm. The ribs strengthen ventrally and terminate in large tubercles which are the bases of robust spines. Ribs are rectiradiate to gently prorsiradiate and may be locally irregular or weakly sinuous at large shell diameters (Pl. 19, fig. 4).

Material.—Twelve specimens in sandstone and siltstone of the Fannin Formation.

Discussion.—This is the stratigraphically highest ranging, and amongst the most strongly ornamented species of *Metaderoceras* yet described in North America. We previously included this form in *M. mouterdei* with which it has morphological similarities (Smith *et al.*, 1988; Thomson and Smith, 1992). It is difficult, however, to demonstrate that *M. mouterdei* and *M.? aff. mouterdei* represent variants, particularly as there is a discrepancy in stratigraphic range. In fact the exceptionally broad, *Eoderoceras*-like venter of *M.?* aff. *mouterdei* makes it difficult to unequivocally accommodate this form in the genus *Metaderoceras*. *Eoderoceras*-like forms are known in the eastern Pacific but they characterize the lowest Pliensbachian (Hillebrandt, 1981, 1987).

Occurrence.—This form is apparently indigenous to North America where it characterizes the Whiteavesi to basal Kunae zones.

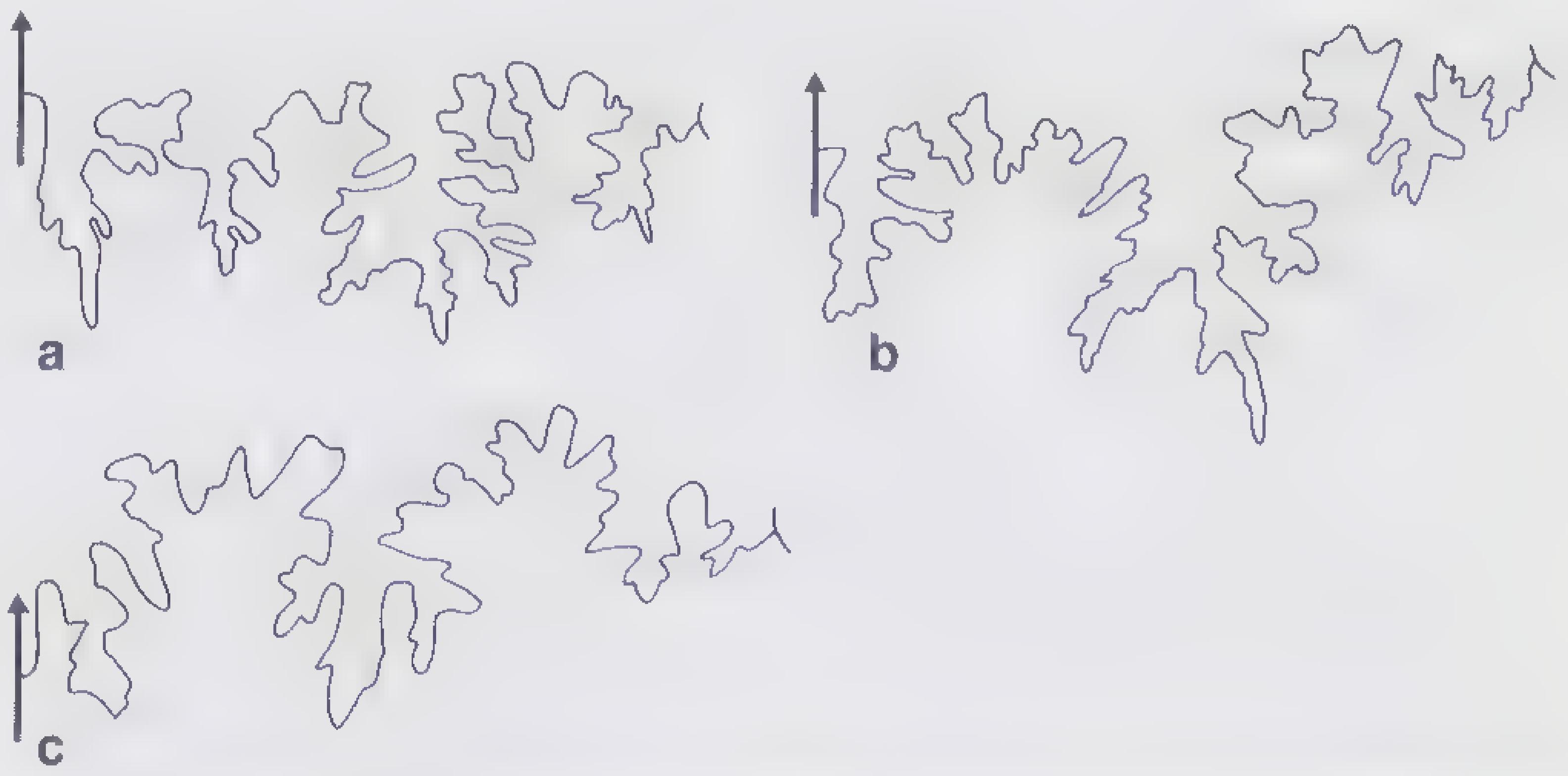
Localities.—C03, C05, ET3, E38.

Age.—Whiteavesi to Kunae Zone (Pliensbachian).

Metaderoceras talkeetnaense
Thomson and Smith, 1992
Plate 17, figures 2, 3; Text-figures 33a, 34c

Crucilobiceras cf. *C. muticum* (d'Orbigny). Imlay, 1981, p. 35, pl. 7, figs. 6–10, 12–15.
Uptonia cf. *ignota* (Simpson). Hillebrandt, 1987, pl. 2, figs. 2–4.
Metaderoceras aff. *muticum* (d'Orbigny). Smith, Tipper, Taylor, and Guex, 1988, pl. 2, figs. 7–9.
Metaderoceras talkeetnaense Thomson and Smith, 1992, p. 20, pl. 6, fig. 1; pl. 7, figs. 1–5.

Description.—Evolute with a quadrate to compressed to subquadrate whorl section. The ornamentation consists of simple ribs that terminate in tubercles at the ventro-lateral shoulder. Ribbing is sharp on the innermost whorls becoming coarser with growth. Rib frequencies range from 15 ribs per half whorl up to 20 on outer whorls.



Text-figure 34.—Traces of the septal suture for species of the Eoderoceratidae at whorl heights (WH) indicated. a. *Metaderoceras evolutum* (Fucini, 1921) (GSC 98689, WH = 5.8 mm); b. *Metaderoceras*? aff. *mouterdei* Frebold, 1970 (GSC 87797, WH = 10.8 mm); c. *Metaderoceras talkeetnaense* Thomson and Smith, 1992 (GSC 98703, WH = 7.7 mm).

Type material.—Holotype: Imlay, 1981, pl. 7, figs. 12, 13. Paratypes: Imlay, 1981, pl. 7, figs. 6–10, 14, 15.

Material.—Fifty-two specimens in siltstone, mudstone and sandstone of the Ghost Creek and Fannin formations.

Discussion.—Compared with *M. talkeetnaense*, *M. mouterdei* is more evolute, has a somewhat more compressed whorl section, and stronger, less densely spaced ribs which tend to be less prorsiradiate. *M.?* aff. *mouterdei* has a much broader venter and is more coarsely and less densely ribbed throughout. *M. evolutum* is more evolute, has a more compressed whorl section, and commonly has two or three ribs merging into a tubercle whereas *M. talkeetnaense* has separate ribs which always terminate in a tubercle.

The species *Acanthopleuroceras sutherlandbrowni* was established by Frebold (1970) based on a moderately well preserved holotype from Maude Island together with some unfigured, poorly preserved external molds from elsewhere which Frebold states (1970, p. 440) did not contribute to the original description. Frebold indicated the presence of a roof-like venter bearing a blunt low keel. The outer half whorl of the holotype is non-septate and has collapsed during sediment compaction causing the venter to arch. Examination of earlier, septate whorls shows that the whorl section is compressed but the venter is nevertheless much broader than in the outer half whorl and is gently convex rather than "roof-like". A keel is not evident on any of the whorls. The assignment of Frebold's species to the genus *Acanthopleuroceras* is therefore

not appropriate. It may be related to *Metaderoceras talkeetnaense* because it has similar volution and ornamentation although the whorl shape is more compressed, the expansion rate somewhat higher, and the costation sharper than is usually the case for this species. It may be a variant of *M. talkeetnaense* but more and better preserved material is needed before the issue can be resolved; should it prove to be the case, the name *sutherlandbrowni* would have priority.

Occurrence.—*M. talkeetnaense* is known from the Whiteavesi and Freboldi zones of Alaska, British Columbia, and Oregon (Imlay, 1981; Smith *et al.*, 1988; Thomson and Smith, 1992). It has also been collected from the Meridianus Zone in Argentina (Hillebrandt, 1987, 1990a).

Localities.—A11, C03, D16–18, ET1, ET2, E28, E35, E38, E40, E42, FT1, F02, GT1–3, G06–09, H10–12, I02, I07, I15.

Age.—Whiteavesi and Freboldi zones (Early Pliensbachian).

Metaderoceras sp.
Plate 17, figure 1; Text-figure 33c

Metaderoceras sp. 1, nov. Cólera, Rivas, Sequeiros, and Valenzuela, 1978, p. 311, pl. 1, fig. 1.

Description.—Large, extremely evolute, slowly expanding form. The umbilical wall is low and steep, the flanks flat and the venter broad and weakly arched producing a subquadrate whorl section. The ribs are strong, rectiradiate to gently prorsiradiate and terminate ventrally in tubercles that are weakly elongated in a spiral direction. The tubercles are situated at the angular ventro-lateral shoulder; the venter is featureless. The figured specimen is large and completely septate. Although the specimen is somewhat corroded, the septal suture is fairly simple.

Material.—Two poorly preserved specimens in coarse, calcareous sandstone occurring within the Ghost Creek Formation.

Discussion.—As far as preservation permits comparison, this form is identical to a new but unnamed species of *Metaderoceras* collected in Zaragoza Province, Spain (Cólera *et al.*, 1978). Unfortunately there is not enough well preserved material either in Spain or North America to formalize a species name. In the Queen Charlotte Islands this rare species is distinguishable from the other species of *Metaderoceras* by its extremely evolute, slowly expanding and densely ribbed shell.

Occurrence.—The Spanish material originates from the upper part of the Ibex Zone. Although not in place, both of the Queen Charlotte Island specimens were collected some distance below localities yielding acanthopleuroceratids characteristic of Ibex Zone correlatives. They were associatated with both in place and *ex situ* specimens indicating the Imlayi Zone.

Locality.—BT1.

Age.—Probably Imlayi Zone (Early Pliensbachian).

Family **DACTYLIOCERATIDAE** Hyatt, 1867

Genus **REYNESOCERAS** Spath, 1936

Aveyroniceras Pinna and Levi-Setti, 1971, p. 64.
Bettoniceras Wiedenmayer, 1977, p. 80.

Type species.—*Ammonites ragazzonii* Hauer, 1861, p. 415, pl. 1, figs. 16, 17, by original designation (Spath, 1936, p. 444).

Remarks.—The tuberculate innermost whorls are *Coeloceras*-like, whereas the outer whorls are non-tuberculate and rounded in section. Whorls may egress and ribbing become irregular in microconchs. *Aveyroniceras* is included in this genus because the type species of *Aveyroniceras* and *Reynesoceras* constitute a macroconch-microconch pair as argued by Fantini Sestini (1975), Braga (1983), and Meister (1989).

Age and distribution.—A Tethyan form ranging through beds that correlate with the Davoei and Margaritatus zones.

Reynesoceras colubriforme (Bettoni, 1900)
Plate 17, figures 4, 5; Text-figure 35b

Coeloceras colubriforme Bettoni, 1900, p. 75, pl. 7, fig. 10; Fucini, 1905, p. 294, pl. 47, figs. 13, 14; Parisch and Viale, 1906, p. 161, pl. 9, figs. 5–8.
Reynesoceras aff. *fallax* (Fucini). Du Dresnay, 1963, p. 151, pl. 2, fig. 1.
Prodactylioceras cf. *colubriforme* (Bettoni). Pinna, 1966, p. 348, pl. 10, fig. 6.
Prodactylioceras colubriforme (Bettoni). Fischer, 1971, p. 112, pl. 2, fig. 10; Cantaluppi and Montanari, 1971, p. 65, pl. 12, fig. 2.
Indunoceras (Bettoniceras) colubriforme (Bettoni). Wiedenmayer, 1977, p. 81, pl. 16, figs. 8–10.
Reynesocoeloceras (Bettoniceras) cf. *colubriforme* (Bettoni). Hillebrandt, 1981, pl. 7, fig. 9.
Aveyroniceras colubriforme (Bettoni). Smith and Tipper, 1986, fig. 2.6; Smith, Tipper, Taylor, and Guex, 1988, pl. 3, figs. 5, 6.

Description.—An evolute form that has a depressed nucleus and a broadly rounded venter to umbilical diameters of approximately 7 mm. At this point the prorsiradiate, tuberculate ribs are replaced by more densely spaced, sharper ribs that are non-tuberculate, and the whorl section becomes rounded and less depressed.

Type material.—Holotype: Bettoni, 1900, pl. 7, fig. 10. Neotype: Wiedenmayer, 1977, p. 81, pl. 16, fig. 8–10.

Material.—Twenty specimens in calcareous, fine grained sandstone of the Fannin Formation.

Measurements.—See Table 22.

Discussion.—This species differs from *R. acan-*

Table 22.—Measurements of *Reynescoceras colubriforme* (Bettoni, 1900). All measurements are in mm.

specimen no.	*DMAX*	*D*	*UD*	*U*	*WW*	*WWD*	*WH*	*WHD*	*WWWH*	*PRHW*
GSC 87796	c50	44	23	52.3	142	32.3	13.2	30	107.1	32
	—	—	15	—	—	—	—	—	—	c29
	—	—	8	—	—	—	—	—	—	12
GSC 98595	—	25	12	48	9.5	38	7.2	28.8	131.9	23
	—	—	5.5	—	—	—	—	—	—	14

thoides (Reynès, 1868) by the narrower venter of its early whorls, its less rounded whorl sections in later whorls and its ribbing which is very regular, not quite as dense, and stronger.

Occurrence.—*Reynesoceras colubriforme* is a Tethyan species known from Italy (Wiedenmayer, 1977), Morocco (Du Dresnay, 1963), South America (Hillebrandt, 1981), and Nevada (Smith and Tipper, 1986). The species possibly arises in the Ibex Zone (Fischer, 1971) but is common in the Davoei and Margaritatus zones.

Localities.—D21, E57, I07, I14.

Age.—Freboldi and Kunae zones (Pliensbachian).

Reynesoceras aff. **colubriforme** (Bettoni, 1900)
Plate 18, figure 2

Description.—A non-septate whorl fragment from an evolute ammonite with a subrounded, depressed whorl section (WWWH=c118). Ribs are wiry, densely spaced and show asymmetry. On one side of the fragment ribs are simple; on the opposite side ribs coalesce at intervals to form radially elongate tubercles positioned near the middle of the flank.

Material.—One internal mold from the Fannin Formation.

Discussion.—This specimen differs from *R. colubriforme* only in the presence of radially elongate swellings which might be pathologic considering their asymmetry.

Locality.—E57.

Age.—Kunae Zone (Late Pliensbachian).

Reynesoceras italicum (Fucini, 1901)
Plate 18, figure 3

Coeloceras italicum Meneghini *in* Fucini, 1901a, p. 98, pl. 13, fig. 4.
Coeloceras italicum Meneghini. Fucini, 1905, p. 287, pl. 46, figs. 11–14.
Coeloceras cf. *italicum* Meneghini. Schröder, 1927, p. 98, pl. 4, fig. 10.
non *Prodactylioceras* cf. *P. italicum* (Meneghini). Imlay, 1968, p. 28, pl. 2, figs. 14–16.
Prodactylioceras italicum (Fucini). Fischer, 1971, p. 111, p. 2, fig. 12; Dommergues, Ferretti, Géczy, and Mouterde, 1983, p. 482, pl. 7, figs. 7–12.
Prodactylioceras italicum fucinii Fischer, 1971, p. 111, pl. 2, figs. 8, 11.
Aveyroniceras italicum (Meneghini). Pinna and Levi-Setti, 1971, p. 66, pl. 1, fig. 10 only.
P. (Aveyroniceras) italicum (Meneghini *in* Fucini). Géczy, 1976, p. 145, pl. 25, figs. 8, 9; pl. 26, figs. 1–4.
P. (Aveyroniceras) italicum fucinii Fischer. Géczy, 1976, p. 147, pl. 26, figs. 5, 6.
Aveyroniceras cf. *italicum* (Meneghini). Dubar and Mouterde, 1978, p. 54, pl. 3, fig. 2.
Bettoniceras italicum (Fucini). Wiedenmayer, 1980, p. 57, pl. 5, figs. 9, 10.
Prodactylioceras italicum italicum (Fucini). Imlay, 1981, p. 38, pl. 10, fig. 3.
Reynesoceras italicum (Fucini). Braga, 1983, p. 323, pl. 16, fig. 4.

Description.—An evolute, slowly expanding form with a rounded whorl section. Ribs are simple, sharp and densely spaced, reaching densities of 50 to 60 per half whorl. The small nucleus is tuberculate and densely ribbed.

Type material.—Holotype: a museum specimen labelled with its new name by Meneghini but not published until the work of Fucini (1901a, pl. 13, fig. 4).

Material.—Five specimens preserved in dark shale, siltstone and fine sandstone of the Rennell Junction Member and upper Fannin Formation sandstones.

Occurrence.—A species that is widespread in the circum-Mediterranean area where it is found in beds that correlate with the Davoei and Margaritatus zones. In the North Pacific it is known in Alaska (Imlay, 1981); Oregon (Smith, 1981), possibly the Yukon (Frebold, 1970, pl. 4, fig. 1), and Japan (Hirano, 1971).

Localities.—A13, I05, I06.

Age.—Freboldi and Kunae zones (Pliensbachian).

Reynesoceras ragazzonii (Hauer, 1861)
Plate 18, figures 6, 7; Text-figure 35d

Ammonites Ragazzonii Hauer, 1861, p. 145, pl. 1, figs. 16, 17.
Coeloceras Ragazzonii Hauer. Fucini, 1901a, p. 92, pl. 13, figs. 6, 7; Bettoni, 1900, p. 73, pl. 7, figs. 4–7; pl. 8, figs. 15–17; pl. 9, fig. 11; Fucini, 1908a, p. 94, pl. 1, fig. 25; Monestier, 1934, p. 93, pl. 6, figs. 13, 15–17, 19 and 24 only; Fucini, 1935, p. 167, pl. 38, fig. 7.
Coeloceras sub-anguinum Meneghini. Del Campana, 1900, p. 629, pl. 8, fig. 43 only.
Reynesoceras cf. *ragazzonii* (Hauer). Cantaluppi, 1966, p. 155, pl. 17, fig. 7.
Reynesoceras ragazzonii (Hauer). Cantaluppi and Brambilla, 1968, p. 294, pl. 26, fig. 11; Cantaluppi and Savi, 1968, p. 229, pl. 19, figs. 7, 8; Elmi, Atrops, and Mangold, 1974, p. 28, pl. 1, fig. 7; Fantini Sestini, 1975, p. 463, pl. 52, figs. 1–4, 6, 8; Wiedenmayer,

Table 23.—Measurements of *Reynesoceras ragazzonii* (Hauer, 1861). All measurements are in mm.

specimen no.	*DMAX*	*DPHRAG*	*D*	*UD*	*U*	*WW*	*WWD*	*WH*	*WHD*	*WWWH*	*PRHW*
GSC 98714	c24.7	—	c24.7	c12.3	49.8	c9.8	39.7	c7	28.3	140	22
	—	—	c18.5	c8	43.23	c10.6	57.3	c5.6	30.3	189	21
GSC 87800	27	c22	27	14	51.9	10	37	7.1	26.3	141	18
	—	—	22	9.8	44.5	10.7	48.6	6.7	30.5	160	19
	—	—	—	7	—	10.2	—	5	—	204	19

1977, p. 82, pl. 16, figs. 13, 14; Wiedenmayer, 1980, p. 61, pl. 6, figs. 1–6; Braga, 1983, p. 328, pl. 16, figs. 10–14; Meister, 1989, p. 35, pl. 5, figs. 2, 6, 7.

Reynesoceras cf. *ragazzonii* (Hauer). Imlay, 1968, p. C28, pl. 1, figs. 22–28 only.

Reynesoceras cf. *aegrum* (Fucini). Imlay, 1968, p. C28, pl. 1, figs. 20–21.

Description.—A midvolute form that egresses at umbilical diameters of 8–10 mm at which point the whorl shape becomes rounded and less depressed. Sutures are unclear but specimen GSC 87800 appears to have an incomplete body chamber approaching one whorl in length. Ribs are simple, densely spaced, and prorsiradiate on the flank. Ribbing becomes less dense or is interrupted by constrictions on the outer whorl. On the inner whorls there are small tubercles at the ventrolateral shoulder.

Type material.—Lectotype: Hauer, 1861, pl. 1, figs. 16–17 designated by Wiedenmayer (1977, p. 82).

Material.—Four specimens preserved in sandstone of the Fannin Formation.

Measurements.—See Table 23.

Discussion.—This is a microconchiate form that has been paired with the species *Aveyroniceras acanthoides* (Braga, 1983; Meister, 1989), a species not yet recognized in the Queen Charlotte Islands.

Occurrence.—This is a Tethyan species characteristic of the circum-Mediterranean countries where it is found in the Algovianum Zone of Spain and Margaritatus Zone correlatives elsewhere.

Localities.—DT1, I06.

Age.—Kunae Zone (Late Pliensbachian).

Reynesoceras sp.
Plate 18, figure 5

Description.—Evolute with a subrounded, depressed whorl section (WWWH=c110). The inner whorls on the figured specimen are only moderately well preserved but appear to be coronate. The outermost whorl fragment is non-septate. Ribs are simple, strong and prorsiradiate.

Material.—Two fragments of internal molds from the upper Fannin Formation.

Discussion.—These specimens are characterized by the coarseness of their ribbing and a relatively narrow whorl section, a combination not normally seen in the more coarsely ribbed species of *Reynesoceras* such as *R. indunense.* They could either represent a new species or be coarsely ribbed variants of *R. colubriforme* which also occurs at locality E57.

Locality.—E57, FT2.

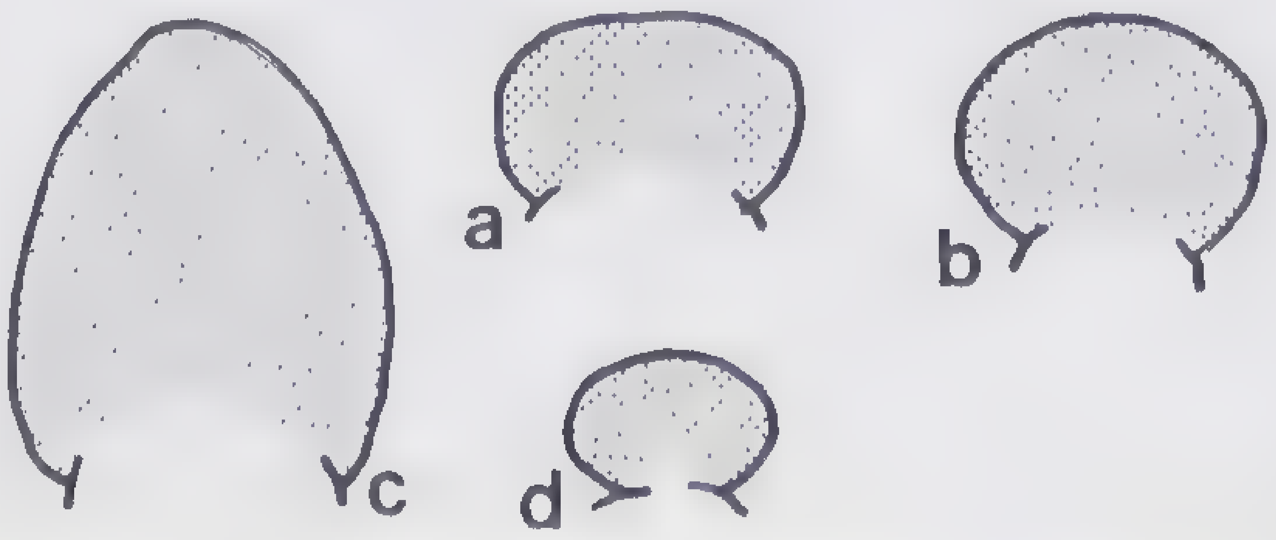
Age.—Kunae Zone (Late Pliensbachian).

Reynesoceras? sp.
Plate 18, figure 4

Description.—An evolute, slowly expanding specimen with gently rounded flanks. The ribs, which have densities of approximately 15 per half whorl, are wiry and prorsiradiate. Just beneath the umbilical seam several of the ribs bifurcate. The venter is not visible.

Material.—One slightly distorted internal mold preserved in dark siltstone interlaminated with green sandstone of the upper Fannin Formation.

Discussion.—This specimen was not in place but was associated with other ammonites and is in rock lithologically similar to the Kunae Zone outcrop adjacent to where it was found. The presence of bifurcating ribs sets it apart from all other dactylioceratids found at this level. Bifurcating ribs are normally associated with *Dactylioceras* of the Toarcian. Wiedenmayer (1980, *Aveyroniceras striatum*), Imlay (1968, *Dactylioceras* cf. *kanense, Reynesoceras* cf. *ragazzonii*), and Hirano (1973, *Dactylioceras helianthoides*) report Pliensbachian dactylioceratids with this feature but the Queen Charlotte Islands specimen appears to be most similar to two specimens of *Dactylioceras?* sp. reported by Braga (1983) from the Algovianum Zone (equivalent to



Text-figure 35.—Whorl shape cross-sections for species of the Dactylioceratidae. Figures are natural size. a,c. *Reynescoeloceras mortilleti* (Meneghini, 1875) (a. GSC 98673, c. GSC 98675); b. *Reynesoceras colubriforme* (Bettoni, 1900) (GSC 87796); d. *Reynesoceras ragazzonii* (Hauer, 1861) (GSC 87800).

the upper Margaritatus to lower Spinatum Zone) of southern Spain. The Spanish material appears to have flatter flanks and finer ornamentation, however.

Locality.—ET4.

Age.—Kunae Zone (Late Pliensbachian).

Genus **REYNESOCOELOCERAS** Géczy, 1976

Indunoceras Wiedenmayer, 1977, p. 75.
Cetonoceras Wiedenmayer, 1977, p. 79.

Type species.—Ammonites (Stephanoceras) crassus Young and Bird var. *indunensis* Meneghini (Meneghini, 1881, p. 72, pl. 16, fig. 4), by original designation (Géczy, 1976, p. 123).

Remarks.—Internal whorls are cadiconic and tuberculate with tri- or bifurcating ribs and this stage persists to large shell diameters compared with *Reynesoceras.* The outer whorls are serpenticonic with simple, non-tuberculate ribs. A full discussion of this genus is given by Géczy (1976, p. 123) and Wiedenmayer (1977, p. 75).

Age and distribution.—Restricted to the Tethyan Realm and ranging from the Jamesoni to the Margaritatus Zone, with most occurrences in the Davoei Zone. Reports of Sinemurian occurrences (Fischer, 1971; Wiedenmayer, 1977) were based on a misinterpretation of the biostratigraphy at Monte Cetona in Italy (Wiedenmayer, written commun., 1982).

Reynesocoeloceras cf. **incertum** (Fucini, 1905)
Plate 12, figure 1

cf. *Coeloceras incertum* Fucini, 1905, p. 312, pl. 51, figs. 4–7.
cf. *Coeloceras (Coeloceras) incertum incertum* Fucini. Fischer, 1971, p. 110, fig. 5j.
cf. *Coeloceras (Reynesocoeloceras) incertum* Fucini. Géczy, 1976, p. 131, pl. 23, figs. 4, 5.
cf. *Crucilobiceras dolosum* Wiedenmayer, 1977, p. 60, pl. 13, figs. 4, 5.
cf. *Reynesocoeloceras* sp. gr. *incertum* (Fucini). Dommergues, Ferretti, Géczy, and Mouterde, 1983, p. 475, pl. 1, figs. 23–26.
Reynesocoeloceras cf. *incertum* (Fucini). Thomson and Smith, 1992, p. 30, pl. 12, fig. 6.

Description.—An evolute, slowly expanding form with a depressed whorl section and an arched venter. Densely spaced, prorsiradiate primary ribs terminate at the ventro-lateral shoulder in sharp tubercles from which two strong secondary ribs arise. A fragment of the last part of the outermost whorl (Pl. 12, fig. 1b) shows that the ribs have become stronger and simple, and the whorl section more rounded.

Type material.—Fucini, 1905, pl. 51, figs. 4–7, Text-figure 131.

Material.—One specimen preserved in fine grained sandstone of the Rennell Junction Member.

Occurrence.—*R. incertum* is a circum-Mediterranean form found in Hungary (Géczy, 1976), Italy (Fucini, 1905), and France (Dommergues *et al.*, 1983), where it characterizes the Davoei Zone. In North America it has been reported from the Freboldi Zone of north-central British Columbia (Thomson and Smith, 1992).

Locality.—E51.

Age.—Basal Kunae Zone (Late Pliensbachian).

Reynesocoeloceras grahami, new species
Plate 12, figures 2, 5, 6

Description.—A slowly expanding, evolute form whose coronate inner whorls bear stout, prorsiradiate ribs terminating ventrally in robust tubercles. Intermediate whorls are more rounded in cross-section, display a significant increase in rib frequency and the ribs become simple. On the outermost third of a whorl of the holotype (Pl. 12, fig. 2) and one of the paratypes (Pl. 12, fig. 6) small sharp tubercles appear at the ventro-lateral shoulder and the venter flattens. The paratype figured on Plate 12, figure 5 is interpreted as a coarse-ribbed variant that never completely loses its tubercles although they do become less pronounced. On its outer one-eighth whorl, ornamentation coarsens, tubercles sharpen and become more prominent, and the last rib flares and thickens.

Type material.—Holotype: GSC 98671 (Pl. 12, fig. 2). Paratypes: GSC 98651 (Pl. 12, fig. 5), GSC 87809 (Pl. 12, fig. 6).

Material.—One external mold in fine-grained sandstone and approximately 10 specimens in a silty limestone from the Rennell Junction Member.

Measurements.—See Table 24.

Derivation of name.—This species is named after Graham Island, the large northern island of the Queen Charlotte Islands archipelago.

Discussion.—*Reynesocoeloceras grahami* is a large species, reaching diameters up to 65 mm. It differs from all other species of *Reynesocoeloceras* by the robustness of its ribbing in its early whorls which persists to umbilical diameters in excess of 15 mm.

Localities.—FT1, F02, GT3.

Age.—Freboldi Zone (Early Pliensbachian).

Reynesocoeloceras mortilleti
(Meneghini, 1875)
Plate 12, figures 3, 4, 7, 8;
Text-figures 26f, 35a,c

Ammonites (Stephanoceras) mortilleti Meneghini, 1875, appendix, pl. 4, fig. 7; 1876, appendix, p. 21, pl. 6, figs. 1, 2.
Coeloceras mortilleti Meneghini. Fucini, 1901a, p. 97, pl. 13, fig. 11; 1905, p. 288, pl. 46, fig. 10; 1908b, p. 93, pl. 3, figs. 30, 31.
Prodactylioceras cf. *P. mortilleti* (Meneghini). Imlay, 1968, p. C29, pl. 2, figs. 11–13, 19, 20.

Table 24.—Measurements of *Reynesocoeloceras grahami,* new species. All measurements are in mm.

specimen no.	DMAX	D	UD	U	WW	WWD	WH	WHD	WWWH	PRHW
GSC 99047	c49	c49	29	59.2	—	—	10	20.4	—	42
		—	19	—	—	—	—	—	—	22
GSC 98671	50	50	30	60	15.9	31.8	10.5	21.0	151.4	38
(holotype)		—	27	60	c12.5	27.8	10	22.2	125	40
		45	16	—	—	—	—	—	—	15
		—	4.5	—	—	—	—	—	—	9
GSC 87809	c46	c46	29	63	13.5	29.3	9.2	20.0	146.7	37
(paratype)		—	25	—	—	—	—	—	—	35
		—	17	—	—	—	—	—	—	16
		—	10	—	—	—	—	—	—	14
		—	6	—	—	—	—	—	—	11
GSC 98651	55	55	32	58.2	15.7	28.5	13	23.6	120.8	32
(paratype)		47	28	59.6	14	29.8	10	21.3	140	31
		—	18	—	—	—	—	—	—	12
		—	10	—	—	—	—	—	—	10

Aveyroniceras italicum (Meneghini). Pinna and Levi Setti, 1971, p. 66, pl. 1, fig. 11 only.

Indunoceras (Bettoniceras) mortilleti (Meneghini). Wiedenmayer, 1977, p. 80, pl. 16, fig. 7.

Reynesocoeloceras (Bettoniceras) cf. *mortilleti* (Meneghini). Hillebrandt, 1981, p. 512, pl. 7, figs. 10, 11.

Reynesoceras mortilleti (Meneghini). Braga, 1983, p. 330, pl. 16, fig. 15.

Description.—An evolute form that has a coronate whorl section until umbilical diameters of approximately 15 to 20 mm. Regularly spaced tubercles occur at the angular ventro-lateral shoulder where some primary ribs loop together; two or, more commonly, three secondary ribs arch gently forward from the tubercles across the venter. Between the tubercles ribs are simple.

As growth proceeds, the whorl shape gradually becomes less depressed and more rounded with the tubercles becoming irregularly spaced and radially elongate. Outer whorls are simply and densely ribbed; tubercles are rare.

Type material.—Lectotype: Meneghini, 1876 (appendix), pl. 6, fig. 2 refigured by Fucini, 1908b, pl. 3, fig. 30. Paralectotypes: Meneghini, 1875 (appendix), pl. 4, fig. 7; 1876 (appendix), pl. 6, fig. 1.

Material.—Fifty-eight specimens, mostly fragments, preserved in fine grained calcareous sandstone and siltstone of the Fannin Formation.

Measurements.—See Table 25.

Occurrence.—*Reynesocoeloceras mortilleti* is a Tethyan species ranging from the Jamesoni Zone to the Margaritatus Zone (Wiedenmayer, 1977) in the circum-Mediterranean area. In South America it occurs in beds equivalent to the Margaritatus zone (Hillebrandt, 1981, 1987).

Localities.—B5, DT1, D22, E52, FT2, GT3, I06, I15.

Age.—Kunae and, rarely, the Freboldi Zone (Pliensbachian).

Reynesocoeloceras spp.
Plate 11, figures 7, 8

Description.—Specimen GSC 98668 (Pl. 11, fig. 7) is a distorted external mold of an evolute form that had a depressed *Coeloceras*-like whorl section. Strong primary ribs terminate at the ventro-lateral shoulder in tubercles from which two or three weaker secondary ribs develop; intercalated secondary ribs also appear to be present.

Specimen GSC 98869 (Pl. 11, fig. 8) also has a depressed, *Coeloceras*-like whorl section but the ventrolateral shoulders are less sharp. Ribbing is very strong and the tubercles at the ventro-lateral shoulder are blunt and slightly radially elongate. Some ribs remain

Table 25.—Measurements of *Reynesocoeloceras mortilleti* (Meneghini, 1875). All measurements are in mm.

specimen no.	DMAX	D	UD	U	WW	WWD	WH	WHD	WWWH	PRHW	SRHW	THW
GSC 98673	34	31	15	48.4	16.4	52.9	9.2	29.7	178.3	26	37	c8
GSC 98674	27	24.5	12	50	—	—	7	—	—	23	32	6
	—	—	9	—	13.5	—	5.5	—	245.5	—	—	—
GSC 98675	—	—	c29	—	c20.6	—	c14.9	—	138.3	—	—	—
GSC 99019	—	—	c20	—	c18.1	—	c12.4	—	146	25	41	c12

Table 26.—Measurements of *Amaltheus stokesi* (Sowerby, 1818). All measurements are in mm.

specimen no.	*WW*	*WH*	*WWWH*
GSC 98717	c5.5	c9.5	c57.9

simple while others give rise to two secondary ribs. The primary and secondary ribs are equally strong.

Material.—Three external molds preserved in calcareous sandstone.

Discussion.—These specimens are placed in *Reynesocoeloceras* because they are moderately large and yet still retain their *Coeloceras*-like whorl shape and coarse ribbing. The state of preservation does not permit a confident species assignment.

Occurrence.—Specimen GSC 98668 was not found in place but was associated with a Whiteavesi Zone fauna thought to originate from the Rennell Junction Member of the Fannin Formation (loc. GT1). This form may also be present at locality I02. Specimen GSC 98669 was found at locality E40 from the Whiteavesi Zone of the Rennell Junction beds.

Family **AMALTHEIDAE** Hyatt, 1867

Genus **AMALTHEUS** de Montfort, 1808

Proamaltheus Lange, 1932, p. 238.
Nordamaltheus Repin, 1968, p. 111.

Type species.—*Amaltheus margaritatus* de Montfort, 1808, p. 91, by monotypy.

Age and distribution.—A Boreal genus characteristic of the Margaritatus and Spinatum zones. Only five specimens (including the material described below) have been recorded from the allochthonous terrane Wrangellia (Imlay, 1981).

Amaltheus stokesi (J. Sowerby, 1818)
Plate 19, figure 1; Plate 20, figure 3
Text-figure 36a-b

Ammonites stokesi Sowerby, 1818, p. 205, pl. 191.
Amaltheus cf. *A. nudus* (Quenstedt). Imlay, 1955, p. 87, pl. 10, fig. 5.
Amaltheus stokesi (J. Sowerby). Howarth, 1958, p. 3, pl. 1, figs. 5, 7, 12–14; pl. 2, figs. 1, 3, 10; Dean, Donovan and Howarth, 1961, pl. 70, fig. 2; Frebold, 1964a, p. 9, pl. 2, figs. 2–6; Frebold, Mountjoy and Tempelman-Kluit, 1967, p. 14, pl. 1, figs. 1–3, 5, 7; Géczy, 1967, p. 93, pl. 25, fig. 1; Frebold, 1970, p. 3, fig. 1; Repin, 1974, p. 55, pl. 1, figs. 4–9; Frebold, 1975, p. 10, pl. 4, figs. 3, 4; Wiedenmayer, 1980, p. 51, pl. 2, fig. 11; Sey and Kalacheva, 1980, p. 71, pl. 1, figs. 4, 6–8, 11, 13; Imlay, 1981, p. 37, pl. 10, figs. 23, 24, 27, 28; Braga, Comas-Rengifo, Goy, and Rivas, 1985, pl. 1, figs. 6–7; Poulton, 1991, p. 18, pl. 8, figs. 1–8.
Amaltheus cf. *A. stokesi* (Sowerby). Frebold, 1966, p. 2, pl. 1, figs. 1–4.
Amaltheus cf. *margaritatus* de Montfort. Repin, 1968, p. 108, pl. 35.
Amaltheus cf. *A. stokesi* (Sowerby). Hirano, 1971, p. 101, pl. 17, figs. 11a,b.
Amaltheus (Amaltheus) stokesi (Sowerby). Schlegelmilch, 1976, p. 70, pl. 34, fig. 7.
Amaltheus (Proamaltheus) stokesi (Sowerby). Dagis, 1976, p. 21, pl. 10, figs. 5–7.

Description.—Involute form with an ellipsoidal whorl section. The low umbilical wall rounds rapidly into the gently convex flanks. The venter bears a low crenulate keel consisting of forwardly directed chevrons. The prorsiradiate primary ribs curve gently backwards across the flanks then fade somewhat as they project towards the venter; a few primaries bifurcate. Neither the aperture nor the septal suture is visible.

Type material.—Holotype: J. Sowerby, 1818, pl. 191 refigured by Howarth, 1958, pl. 1, fig. 7.

Material.—Two specimens in limestone and calcareous sandstone of the upper Fannin Formation.

Measurements.—See Table 26.

Because of the poor preservation, exact rib counts cannot be made but the density appears to fall within the ribbing density envelope for *A. stokesi* as illustrated by Howarth (1958, fig. 4).

Discussion.—*Amaltheus stokesi* has been treated in detail by Howarth (1958).

Occurrence.—*Amaltheus stokesi* is a species distributed widely throughout the Boreal Realm (Canada, the former Soviet Union, northwest Europe, Alaska) as well as in mixed Tethyan/Boreal faunas of Italy, Hungary, Canada, Japan, and the former Soviet Union. It is characteristic of the lowest subzone (the Stokesi subzone) of the Margaritatus Zone in northwest Europe and it appears to be consistently low in the Upper Pliensbachian in other parts of the world.

Localities.—FT2, GT4.

Age.—Kunae Zone (Late Pliensbachian).

Table 27.—Measurements of *Amaltheus viligaensis* (Tuchkov, 1954). All measurements are in mm.

specimen no.	*D*	*UD*	*U*	*WW*	*WWD*	*WH*	*WHD*	*WW-WH*	*PR-HW*
GSC 87805	24.9	6.9	27.7	6.9	27.7	10.3	41.4	67	13

Amaltheus viligaensis (Tuchkov, 1954)
Plate 20, figure 2; Text-figure 36c

Acanthopleuroceras viligaensis Tuchkov, 1954, p. 109, pl. 2, fig. 4.
Amaltheus (Nordamaltheus) viligaensis (Tuchkov). Repin 1968, p. 111, pl. 33, figs. 1–5; pl. 37, fig. 3; 1974, p. 62, pl. 5, figs. 6, 8, 10; pl. 7, figs. 2–5.
Amaltheus (Nordamaltheus?) bulunensis Repin, 1968, p. 111, pl. 35, fig. 2.
Amaltheus (Nordamaltheus) aff. *bulunensis* Repin, 1968, p. 112, pl. 36, fig. 1.
Amaltheus (Nordamaltheus) bulunensis Repin, 1974, p. 63, pl. 5, figs. 1–2.

Amaltheus (Nordamaltheus) brodnensis Repin, 1974, in part, p. 64, pl. 5, fig. 4; pl. 66, figs. 1–5.
Amaltheus (Nordamaltheus) brodnensis ventrocalvus Repin, 1974, p. 65, pl. 5, figs. 3, 5, 7, 9.
Amaltheus (Proamaltheus) viligaensis (Tuchkov). Dagis, 1976, p. 27, pl. 16, figs. 1–8; pl. 17, figs. 1, 2.
Amaltheus ex gr. *viligaensis* (Tuchkov). Sey and Kalacheva, 1980, p. 73, pl. 2, figs. 2, 3.
Amaltheus viligaensis (Tuchkov). Smith, Tipper, Taylor, and Guex, 1988, pl. 5, figs. 5, 6.

Description.—Involute, ellipsoidal whorl section; umbilical wall very low passing into convex flanks; venter rounded. A broad, low crenulate keel formed by forwardly inclined chevrons begins to develop on the outer quarter whorl. In earlier whorls the venter is rounded and featureless. Primary ribs are prorsiradiate, arching gently backwards to become rectiradiate near the middle of the flank. Ribs become obsolete on the upper flank except on the outer quarter where the ribs fade but can be seen projecting strongly onto the venter to form chevrons; some chevrons form by intercalation. Weak striations parallel to the primary ribs are evident on the lower half of the flank on the outer quarter whorl.

No sutures are visible but at least the outer half whorl probably represents the body chamber.

Type material.—Holotype: Tuchkov, 1954, pl. 2, fig. 4. Neotype: Repin, 1974, pl. 7, fig. 2.

Material.—One internal mold preserved in calcareous sandstone of the upper Fannin Formation.

Measurements.—See Table 27.

Discussion.—If the development of a keel is a function of maturity in *A. viligaensis,* as suggested by Repin (1974), then the Queen Charlotte Island specimen is a microconch because it is only a third of the diameter of some of the Russian specimens. *A. viligaensis* differs from *A. stokesi* by its wider whorl section and weak to absent keel.

Occurrence.—*A. viligaensis* is a Boreal species restricted to the northern Pacific. In Russia it is characteristic of assemblages correlated broadly with the Spinatum Zone of northwest Europe (Repin, 1974; Dagis, 1976; Sey and Kalacheva, 1980). In outcrops to the north of Vladivostok, the species is associated with *Paltarpites* (=*Protogrammoceras (P.) skidegatense* n. sp.) and *Lioceratoides serotinum* (Bettoni, 1900).

Locality.—E62.

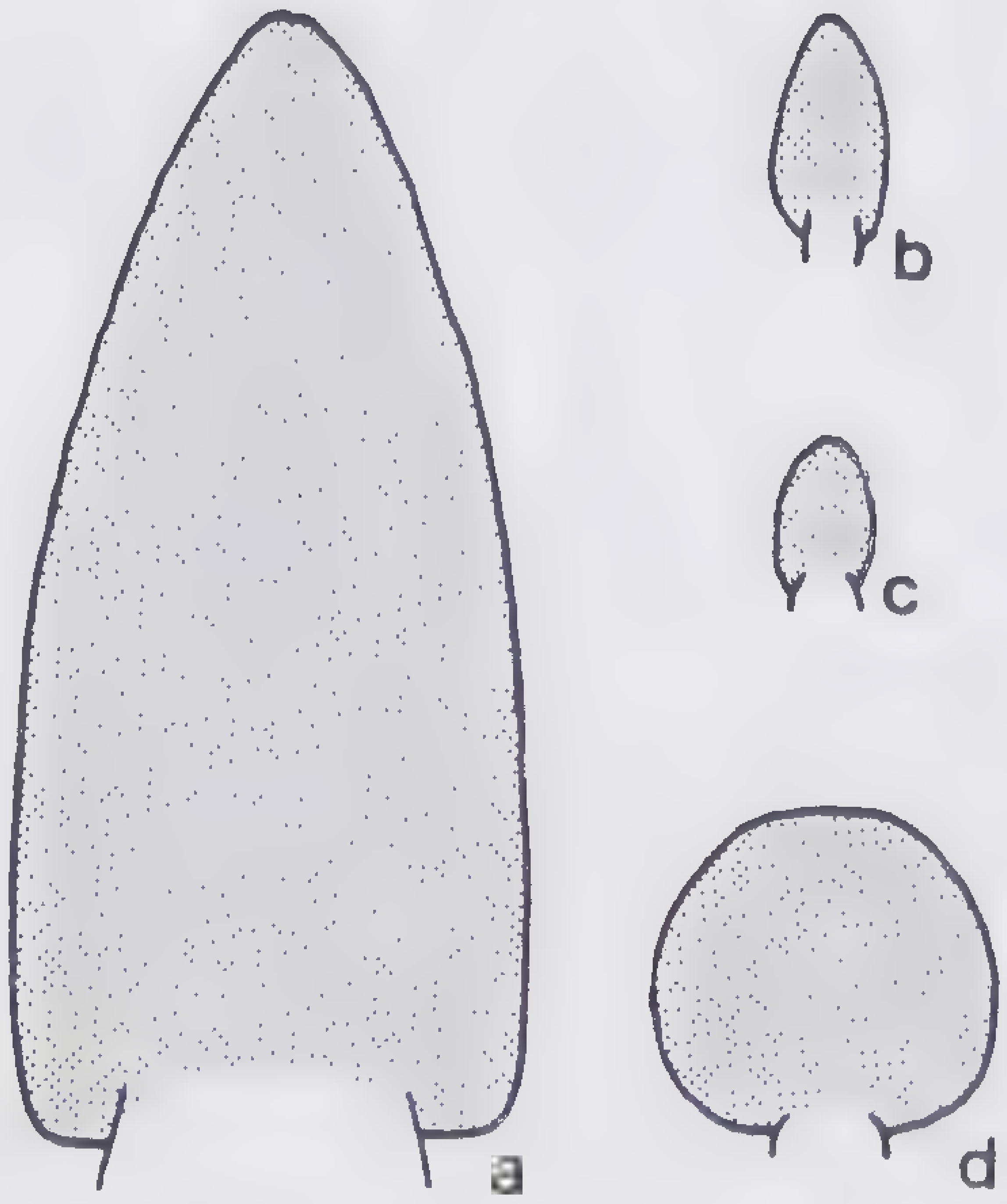
Age.—Carlottense Zone (Late Pliensbachian).

Family **LIPAROCERATIDAE** Hyatt, 1867

Genus **LIPAROCERAS** Hyatt, 1867

Subgenus **BECHEICERAS** Trueman, 1918

Anisoloboceras Trueman, 1918, p. 263.
Becheoceras Dacqué, 1934, p. 292.



Text-figure 36.—Whorl shape cross-sections for species of the Amaltheidae and Liparoceratidae. Figures are natural size. a,b. *Amaltheus stokesi* (J. Sowerby, 1818) (a. GSC 98711, b. GSC 98717); c. *Amaltheus viligaensis* (Tuchkov, 1954) (GSC 87805); d. *Liparoceras (Beicheiceras) bechei* (J. Sowerby, 1821) (GSC 78715).

Type species.—*Ammonites Bechei* J. Sowerby, 1821, p. 143, pl. 280 by original designation (Trueman, 1918, p. 261). A neotype was designated by Donovan and Forsey (1973, p. 13, pl. 2, fig. 4) and refigured by Schlegelmilch (1976, pl. 31, fig. 5).

Remarks.—The shell is inflated and involute with two rows of tubercles and subdued costation. A discussion of the subgenus is given by Spath (1938).

Age and distribution.—The subgenus ranges through the Davoei and Margaritatus zones in northwest Europe, where it was first described. Although rarely abundant, the subgenus is also widespread throughout the Mediterranean region, southern Europe, Indonesia, and the Americas where it may range stratigraphically lower, perhaps as low as the Jamesoni Zone (Géczy, 1976).

Liparoceras (Becheiceras) bechei
(J. Sowerby, 1821)
Plate 19, figure 2; Plate 20, figure 1;
Text-figure 36d

Ammonites Bechei J. Sowerby, 1821, p. 143, pl. 280.
Liparoceras rotticum Krumbeck, 1922, p. 198, pl. 18, figs. 1, 2.
Liparoceras Bechei (Sowerby). Schröder, 1927, p. 225, pl. 12, figs. 6, 7.
Liparoceras (Becheiceras) bechei (J. Sowerby). Spath, 1938, p. 74, pl. 8, fig. 2; pl. 11, figs. 1, 2, pl. 24, fig. 1; Donovan and Forsey, 1973, p. 13, pl. 2, fig. 4; Géczy, 1976, p. 100, pl. 19, figs. 2, 3; Wiedenmayer, 1977, p. 70, pl. 155, figs. 5, 6; Pérez, 1982, pl. 20, fig. 11; Meister, 1986, p. 63, pl. 13, fig. 4.

Table 28.—Measurements of *Liparoceras* (*Becheiceras*) *bechei* (J. Sowerby, 1821). All measurements are in mm.

specimen no.	*DMAX*	*D*	*UD*	*U*	*WW*	*WWD*	*WH*	*WHD*	*WWWH*	*THW*
GSC 98715	38	38	4	10.5	c20.5	53.9	23.5	61.8	87.2	18
GSC 98684	16	16	2	12.5	9.5	59.4	8.7	54.4	109.2	–

Becheiceras cf. *B. bechei* (Sowerby). Frebold, 1964a, p. 8, pl. 3, fig. 1; pl. 4, fig. 1; pl. 5, fig. 1.

Liparoceras (Becheiceras) cf. *L. (B.) bechei* (Sowerby). Imlay, 1968, p. C27, pl. 1, figs. 18, 19.

Becheiceras gr. *bechei* (Sowerby). Blau and Meister, 1991, p. 179, pl. 4, fig. 5.

Description.—Involute form with rounded umbilical wall, flanks and venter. Ornamentation, which is very weak, consists of spiral striations to shell diameters of at least 15 mm, dense ribs and two rows of weak tubercles.

Type material.—Holotype: J. Sowerby, 1821, pl. 280. Neotype: Donovan and Forsey, 1973, p. 13, pl. 2, fig. 4.

Material.—Seven specimens preserved in limestone and calcareous sandstone of the Fannin Formation.

Measurements.—See Table 28.

Occurrence.—A cosmopolitan species, perhaps more abundant in northwest Europe, that Spath (1938) states is characteristic of the upper part of the Davoei Zone. Wiedenmayer (1977), however, has recognized the species from the Margaritatus Zone while Géczy (1976) has questionable occurrences in the Ibex and Jamesoni zones. Pérez (1982) has collected the species from the Upper Pliensbachian of Chile.

Localities.—ET1, ET4, E32, FT2, GT4.

Age.—Whiteavesi to Kunae zones (Pliensbachian).

Genus **OISTOCERAS** Buckman, 1911

Type species.—*Ammonites figulinus* Simpson, 1855, p. 47, by original designation (Buckman, 1911, p. 4, pl. 26A).

Remarks.—Species of *Oistoceras* are evolute and bear simple ribs that show a pronounced forward flexure on the tabulate venter. Most species become bituberculate and less densely ribbed at large shell diameters.

Age and distribution.—This genus (through *O. figulinum*) is thought to be the root-stock of the amaltheid radiation (Howarth, 1958). The genus is known throughout northern Europe (Spath, 1938; Hoffmann, 1982) with occurrences also in Portugal (Mouterde *et al.*, 1983), southern France (Meister, 1986), Spain (Braga *et al.*, 1985), and Hungary (Géczy, 1976). It is characteristic of the Davoei and Margaritatus zones.

Oistoceras compressum, new species
Plate 5, figures 3–12

Uptonia? sp. B. Imlay, 1981, p. 37, pl. 9, figs. 5–7.

(?) *Oistoceras* sp. Braga, Comas-Rengifo, Goy, and Rivas, 1985, pl. 1, fig. 5.

Uptonia? sp. Thomson and Smith, 1992, p. 15, pl. 4, figs. 1, 2.

Description.—Evolute, slowly expanding form with a compressed whorl section. The ribs are simple, sharp, densely spaced, and non-tuberculate. The ribs are subrectiradiate to prorsiradiate across the flanks but swing strongly forward onto the venter where they form chevrons. The ventral ribbing varies from fairly weak in some cases (Pl. 5, figs. 7 and 12) to very strong in most cases. In some specimens evidence of whorl egression, a strengthening of the ventral ornamentation and a slight change in whorl shape to less compressed (*e.g.*, Pl. 5, figs. 5 and 10) suggest that maturity is reached at a small shell diameter.

Type material.—Holotype: GSC 99039 (Pl. 5, fig. 5). Paratypes: GSC 98625 (Pl. 5, fig. 3), GSC 98696 (Pl. 5, fig. 4), GSC 98710 (Pl. 5, fig. 6), GSC 98738 (Pl. 5, fig. 7), GSC 99027 (Pl. 5, fig. 8), GSC 99038 (Pl. 5, fig. 9), GSC 99041 (Pl. 5, fig. 10), GSC 99042 (Pl. 5, fig. 11), GSC 99043 (Pl. 5, fig. 12).

Material.—Approximately 75 internal molds in calcareous sandstone and siltstone of the Rennell Junction Member.

Measurements.—See Table 29.

Derivation of name.—In reference to the characteristically compressed whorls.

Discussion.—This has been a difficult form to place taxonomically since, although it bears a resemblance to some species of the genus *Uptonia* to which it has been questionably referred in the past (Imlay, 1981; Thomson and Smith, 1992; Smith *et al.*, 1988), it is now quite clear that it occurs much later than *Uptonia* as presently understood. *Uptonia* is characteristic of the Jamesoni Zone whereas *O. compressum* occurs in beds correlative with the Davoei Zone.

This species is placed in *Oistoceras* rather than *Uptonia* because of: (1) its resemblance to densely ribbed species of *Oistoceras* such as *O. angulatum* (Quenstedt) (Mouterde *et al.*, 1983, p. 208, pl. 12, figs. 17, 18; pl. 13, fig. 3); (2) the marked forward inflection of the ribs onto the venter, much more strongly than is seen in *Uptonia*; (3) its high stratigraphic position, consistently above the acanthopleuroceratids and with *Dubariceras freboldi* and other elements of the Freboldi Zone.

The species differs from all other species of *Oisto-*

Table 29.—Measurements of *Oistoceras compressum*, new species. All measurements are in mm.

specimen no.	DMAX	D	UD	U	WW	WWD	WH	WHD	WWWH	PRHW
GSC 98696	31	29.0	11.7	40.3	6.3	21.7	9.5	32.8	66.3	22
GSC 99039	24.4	24.4	10.3	42.2	5.5	22.5	6.4	26.2	85.9	25
	—	20.0	7.4	37.0	4.5	22.5	6.2	31.0	72.6	20
GSC 98738	24.1	24.1	8.4	34.9	5.9	24.5	8.1	33.6	72.8	21
	—	—	6.0	—	3.9	—	5.0	—	78.0	17
GSC 99038	16.2	16.2	c6.5	40.1	—	—	—	—	—	24
	—	—	3.9	—	3.6	—	3.8	—	94.7	21
GSC 99041	—	24.6	10.0	40.7	5.5	22.4	7.3	29.7	75.3	19
GSC 99042	—	20.0	8.1	40.5	4.3	21.5	6.2	31.0	69.4	27
GSC 99043	14.4	14.4	5.2	36.1	3.5	24.3	4.4	30.6	79.5	19
MEAN				39.0		22.8		30.7	77.2	
ST. DEV.				2.6		1.2		2.4	8.7	

ceras by its combination of dense, fine ribbing and compressed whorl section.

Localities.—ET3, FT1, F02.

Age.—Freboldi Zone (Early Pliensbachian).

Superfamily **HILDOCERATACEAE** Hyatt, 1867

Family **HILDOCERATIDAE** Hyatt, 1867

Subfamily **ARIETICERATINAE** Howarth, 1955

Genus **ARIETICERAS** Seguenza, 1885

Seguenziceras Levi, 1896, p. 272.
Meneghinia Fucini, 1931, p. 118.
Protoarieticeras, Cantaluppi, 1970, p. 40.
Pseudoarieticeras Cantaluppi, 1970, p. 40.
Géczya Fantini Sestini, 1977, p. 710.

Type species.—*Ammonites algovianus* Oppel, 1862, p. 137 (Seguenza, 1885, p. 67). Lectotype and paralectotype (the latter refigured from Schröder, 1927) designated and figured by Wiedenmayer (1977).

Remarks.—Fairly evolute forms with a quadrate to elliptical whorl section, unicarinate venter and simple, straight to gently sinuous ribs.

Age and distribution.—A widespread genus most characteristic of the Tethyan Realm where it is restricted to the Margaritatus and Spinatum zones. Also known from the Americas (Hillebrandt, 1973, 1981; Imlay, 1968, 1981; Frebold, 1964a), Japan (Hirano, 1973), and Russia (Sey and Kalacheva, 1980).

Arieticeras aff. **algovianum** (Oppel, 1862)
Plate 20, figures 11, 12

aff. *Ammonites algovianus* Oppel, 1862, p. 137.
aff. *Arieticeras algovianum* (Oppel). Wiedenmayer, 1977, pl. 16, figs. 15, 16; Frebold, 1964a, p. 13, pl. 3, figs. 4, 5, pl. 4, fig. 2; 1970, p. 443, pl. 2, fig. 1.
Arieticeras cf. *algovianum* (Oppel). Frebold, 1964a, p. 13, pl. 3, fig. 3, pl. 5, fig. 3; Imlay, 1968, p. 34, pl. 4, figs. 1–8; 1981, p. 40, pl. 10, figs. 16–20.
Arieticeras cf. *domarense* (Oppel). Imlay, 1981, p. 39, pl. 10, figs. 1, 2, 9, 10.
Arieticeras aff. *algovianum* (Oppel). Thomson and Smith, 1992, p. 36, pl. 14, figs. 1–7.

Description.—Evolute with a compressed whorl section bearing a high keel bordered by shallow sulci. Ribs are strong, slightly sinuous and gently rursiradiate in trend.

Type material.—Lectotypes for *Arieticeras algovianum* were designated by Wiedenmayer, 1977, p. 86, pl. 16, fig. 15 (paralectotype) and 16 (lectotype).

Material.—Thirteen internal molds, mostly fragments, preserved in calcareous sandstone of the upper Fannin Formation.

Discussion.—This species is related to *A. algovianum* from which it differs by its slightly greater expansion rate. The species differs from *A.* aff. *domarense* in its higher expansion rate and coarser, more sinuous ribbing; from *A.* cf. *ruthenense* by its less dense, coarser, more sinuous ribbing; from *A. disputabile* by its greater expansion rate end ribbing density; from *A.* cf. *micrasterias* by its less coarse ribbing and more compressed whorl shape; and from *A. lupheri* which has denser ribbing that is strongest on the upper part of the flank.

Occurrence.—This material is conspecific with specimens of *Arieticeras* cf. and aff. *algovianum* from northern British Columbia as figured by Frebold (1964a, 1970) and Thomson and Smith (1992). In Europe, *A. algovianum* is common in the Upper Pliensbachian of the circum-Mediterranean area.

Locality.—I14, I17.

Age.—Kunae Zone (Late Pliensbachian).

Arieticeras disputabile (Fucini, 1908)
Plate 20, figure 5; Plate 21, figure 2
Text-figures 37b, 38o

Hildoceras disputabile Fucini, 1908b, p. 66, pl. 2, figs. 34–36.
Arieticeras gerardi Monestier, 1934, p. 77, pl. 8, figs. 35–37.
Arieticeras apertum Monestier, 1934, p. 50, pl. 10, figs. 21, 23, 37 and 47 only.

Table 30.—Measurements of *Arieticeras disputabile* (Fucini, 1908). All measurements are in mm.

specimen no.	*DM-AX*	*D*	*UD*	*U*	*WW*	*WWD*	*WH*	*WHD*	*WW-WH*	*PR-HW*
GSC 98719	c20	16.8	7.2	43	4.4	26.2	5.0	29.8	88	11

non *Arieticeras disputabile* (Fucini). Monestier, 1934, p. 67, pl. 10, figs. 5, 6; pl. 11, fig. 10; Wiedenmayer, 1980, p. 112, pl. 18, figs. 25–28.

Arieticeras disputabile (Fucini). Fantini Sestini, 1977, p. 730, pl. 35, figs. 5, 7; Braga, 1983, p. 219, pl. 9, figs. 20–23; Braga, Comas-Rengifo, Goy and Rivas, 1985, pl. 2, fig. 9; Meister, 1989, p. 43, pl. 6, fig. 6.

Description.—A very evolute form with a compressed subquadrate to subelliptical whorl section. The low keel is bordered by smooth areas that become incipient sulci on the outer half whorl of the specimen figured on Plate 20, figure 5. The inner whorls are smooth with ribs beginning at an umbilical diameter of approximately 5 mm. The ribs are weakest on the lower part of the flank, stronger and rursiradiate on the rest of the flank and projected onto the venter where they quickly fade.

Type material.—Lectotype: Fucini, 1908b, pl. 2, figs. 35–36.

Material.—Two internal molds and a fragment of an internal mold preserved in calcareous sandstone of the upper Fannin Formation.

Measurements.—See Table 30.

Discussion.—The specimen figured on Plate 20, figure 5 is less compressed and more coarsely ribbed than the specimen figured on Plate 21, figure 2. It compares most favorably with *Arieticeras gerardi* Monestier considered a junior synonym of *A. disputabile.*

Occurrence.—From the Margaritatus Zone of Italy (Fucini, 1908), southern France (Meister, 1989) and Spain (Braga, 1983).

Localities.—FT2, GT4, I14.

Age.—Kunae Zone (Late Pliensbachian).

Arieticeras aff. **domarense** (Meneghini, 1867)
Plate 20, figure 4; Text-figure 37a

aff. *Ammonites (Harpoceras) domarensis* Meneghini, 1867, p. 7; 1870, pl. 1, figs. 4–6, 9.

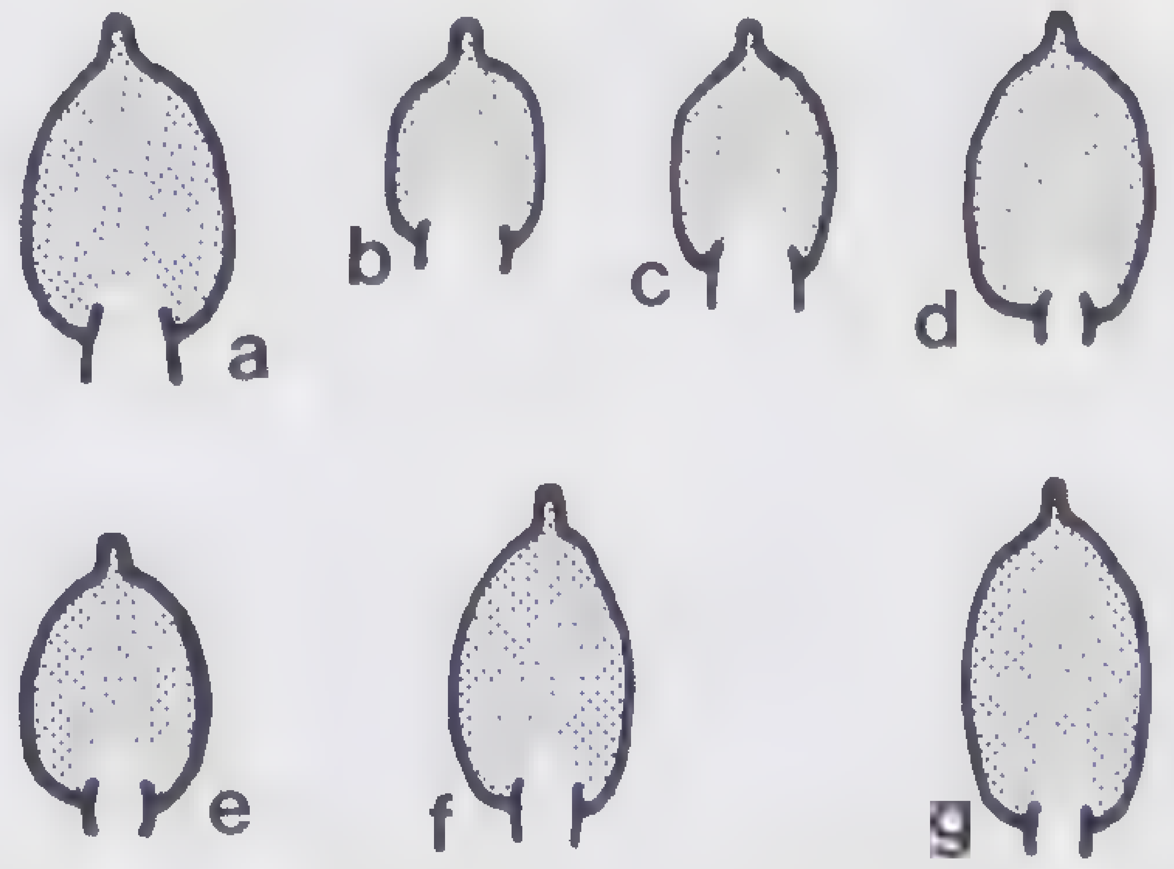
aff. *Hildoceras (Arieticeras) domarense* (Meneghini). Bettoni, 1900, p. 56, pl. 5, fig. 3.

aff. *Arieticeras domarense* (Meneghini). Monestier, 1934, p. 62, pl. 7, figs. 23, 25, 27, 29, 30; pl. 11, fig. 15; Fantini Sestini, 1962, p. 520, pl. 39, figs. 5, 6.

Arieticeras sp. Corvalan, 1962, p. 187, pl. 3, fig. 6.

Arieticeras cf. *algovianum* (Oppel). Hallam, 1965, p. 1488 (reference to Corvalan, 1962, pl. 3, fig. 6; specimen figured by Smith, Tipper, Taylor and Guex, 1988, pl. 4, figs. 10, 11).

Arieticeras cf. *domarense* (Meneghini). Imlay, 1968, p. 33, pl. 4, figs. 9–12; Imlay, 1981, p. 39, pl. 10, figs. 6–8 and 11–14 only.



Text-figure 37.—Whorl shape cross-sections for species of the Arieticeratinae. All figures are ×2. a. *Arieticeras* aff. *domarense* (Meneghini, 1867) (GSC 98718); b. *Arieticeras disputabile* (Fucini, 1908) (GSC 98719); c. *Fieldingiceras fieldingii* (Reynés, 1868) (GSC 98728); d. *Arieticeras lupheri* Imlay, 1968 (GSC 98721); e,f. *Leptaleoceras* sp. (e. GSC 98602, f. GSC 98604); g. *Fieldingiceras pseudofieldingii* (Fucini, 1904) (GSC 98587).

Description.—Very evolute and slowly expanding with a compressed, subquadrate to ovate whorl section (WWWH=c90) bearing a sharp keel bordered by weak sulci. Ribs are wiry, rectiradiate to gently rursiradiate and fairly densely spaced.

Type material.—Syntypes for *Arieticeras domarense*: Meneghini, 1870, pl. 1, figs. 4–6, 9.

Material.—Ten specimens, mostly incomplete, preserved in sandstone of the upper Fannin Formation.

Discussion.—This species appears to be conspecific with material from elsewhere in North America described as *A.* cf. *domarense* (Imlay, 1968, 1981) and it is certainly closely related to this species. The slightly squarer whorl section led Wiedenmayer (1980, p. 125) tentatively to include the form in his new genus *Oregonites,* but the sulci are too weak, the whorl section too compressed and the ribs too fine and regular.

Occurrence.—*A. domarense* is an Upper Pliensbachian, northern Mediterranean species. *A.* aff. *domarense* is known from the Kunae Zone of Alaska (Imlay, 1981), Oregon (Imlay, 1968), and Nevada (Corvalan, 1962; Smith *et al.,* 1988).

Localities.—ET5, E52, E59, I06 and I17.

Age.—Kunae and Carlottense zones (Late Pliensbachian).

Arieticeras lupheri Imlay, 1968
Plate 20, figures 6, 7; Text-figure 37d

Arieticeras lupheri Imlay, 1968, p. C34, pl. 4, figs. 13–28; Wiedenmayer, 1977, p. 84, pl. 17, fig. 2; Wiedenmayer, 1980, p. 113, pl. 19, figs. 19–22.

Description.—Evolute form with a low, weakly sulcate keel. The umbilical wall is low and steep, the flanks flat and the venter broadly rounded. The inner whorls are smooth with ribbing on the outer whorls confined

Table 31.—Measurements of *Arieticeras lupheri* Imlay, 1968. All measurements are in mm.

specimen no.	*DMAX*	*D*	*UD*	*U*	*WW*	*WWD*	*WH*	*WHD*	*WWWH*	*PRHW*
GSC 98720	25	c19	7	36.8	5.0	26.3	6.6	34.7	75.8	c14
GSC 98721	c26	19.5	8	41.0	5.1	26.2	6.5	33.3	78.5	c16
GSC 99020	—	18.5	6.3	34.1	c4.9	26.5	6.5	35.1	75.4	13

to the upper part of the flank. Ribs are densely spaced and rectiradiate to gently rursiradiate in trend.

Type material.—Holotype: Imlay, 1968, pl. 4, figs. 24, 25, 28. Paratypes: Imlay, 1968, pl. 4, figs. 13–24, 26, 27.

Material.—Nine specimens in calcareous sandstone of the upper Fannin Formation.

Measurements.—See Table 31.

Discussion.—Because the specimens available for study are small (maximum shell diameter=c25 mm), it is difficult to make comparisons with the type material which reaches shell diameters of 60 mm or more and undergoes a modification of whorl shape and ornamentation during ontogeny. The Queen Charlotte Island material, however, does show the compressed subquadrate whorl section and ornamentation characteristic of *A. lupheri* at small diameters.

Occurrence.—*A. lupheri* has been reported from the equivalents of the Margaritatus Zone in Switzerland (Wiedenmayer, 1977, 1980) and Oregon (Imlay, 1968).

Localities.—DT1, I06.

Age.—Kunae Zone (Late Pliensbachian).

Arieticeras cf. **micrasterias** (Meneghini, 1874)
Plate 20, figure 8

cf. *Ammonites (Harpoceras) mercati* Hauer var. *micrasterias* Meneghini, 1874, appendix, pl. 2, fig. 14 only; 1875, appendix, p. 3.
cf. *Hildoceras rimotum* Fucini, 1905, p. 282, pl. 45, fig. 12; 1908b, p. 47, pl. 1, figs. 47, 48.
cf. *Hildoceras micrasterias* Meneghini. Fucini, 1908a, p. 12, pl. 2, fig. 13; 1908b, p. 48, pl. 1, figs. 49–51.
cf. *Hildoceras simplex* Fucini, 1908b, p. 45, pl. 1, fig. 39–41.
cf. *Arieticeras micrasterias* (Meneghini). Fucini, 1931, p. 113, pl. 23, fig. 9; Monestier, 1934, p. 71, pl. 7, figs. 11–13, pl. 10, figs. 7–9; Fantini Sestini, 1962, p. 525, pl. 39, fig. 12; 1977, p. 728, pl. 35, figs. 3, 6; Braga, 1983, p. 222, pl. 9, figs. 24, 25; Meister, 1989, p. 44, pl. 6, fig. 8.
cf. *Arieticeras rimotum* (Fucini). Monestier, 1934, p. 71, pl. 10, fig. 55; Ferretti, 1972, p. 109, pl. 14, fig. 2.
cf. *Arieticeras simplex* (Fucini). Wiedenmayer, 1977, p. 112, pl. 18, figs. 35–28; 1980, p. 116, pl. 21, figs. 9–12.
Arieticeras cf. *simplex* (Fucini). Hillebrandt, 1981, p. 516, pl. 8, fig. 7.
Arieticeras sp. Imlay, 1981, p. 40, pl. 10, fig. 21.

Description.—Evolute and slowly expanding. The umbilical wall is steep, the umbilical shoulder abrupt and the flanks flat. The flat venter bears a keel bordered by sulci. The nucleus is smooth to an umbilical diameter of approximately 3 mm; the rest of the whorls bear strong, simple ribs that are gently rursiradiate.

Type material.—Lectotype: Meneghini, 1874, pl. 2, fig. 14 (Braga, 1983).

Material.—Two external and one internal mold in sandstone of the upper Fannin Formation.

Occurrence.—A species characteristic of the Upper Pliensbachian of the circum-Mediterranean area (Braga, 1983; Wiedenmayer, 1980) with other possible occurrences in Alaska (Imlay, 1981) and South America (Hillebrandt, 1981) under the names listed in the above synonymy.

Localities.—D22, I17.

Age.—Kunae Zone (Late Pliensbachian).

Arieticeras cf. **ruthenense** (Reynès, 1868)
Plate 20, figures 9, 10

cf. *Ammonites ruthenense* Reynès, 1868, p. 94, pl. 2, fig. 4.
cf. *Arieticeras ruthenense* (Reynès). Monestier, 1934, p. 59, pl. 8, figs. 2, 4, 5; Wiedenmayer, 1980, p. 115, pl. 20, figs. 21–24, pl. 21, figs. 1, 2; Meister, 1989, p. 52, pl. 8, figs. 3–6, pl. 9, figs. 1–5.
non *Arieticeras* aff. *ruthenense* (Reynès). Frebold, 1964a, p. 14, pl. 4, figs. 3, 4 (=*Leptaleoceras* sp.).
Arieticeras cf. *ruthenense* (Reynès). Thomson and Smith, 1992, p. 37, pl. 15, figs. 1, 2.

Description.—An evolute form with an elliptical to subquadrate whorl section bearing a high keel bordered by flat smooth areas or weak sulci. Ribbing is fairly coarse and densely spaced. Ribs arise near the umbilical shoulder, are rectiradiate in trend and project onto the venter where they fade rapidly.

Type material.—Holotype: Reynès, 1868, pl. 2, fig. 4.

Material.—Six specimens in calcareous sandstone of the upper Fannin Formation.

Measurements.—See Table 32.

Discussion.—The species *A. ruthenense* shows considerable variation in its whorl shape and ornamen-

Table 32.—Measurements of *Arieticeras* cf. *ruthenense* (Reynès, 1868). All measurements are in mm.

specimen no.	*DMAX*	*D*	*UD*	*U*	*WW*	*WWD*	*WH*	*WHD*	*WWWH*	*PRHW*
GSC 98723	35.5	34	12.5	36.8	c9.5	c27.9	13.5	39.7	c70.4	c15
GSC 98724	30	28.5	10.5	36.8	—	26.2	10.4	36.5	—	17

Table 33.—Measurements of *Leptaleoceras* aff. *accuratum* (Fucini, 1931). All measurements are in mm.

specimen no.	*DMAX*	*D*	*UD*	*U*	*WH*	*WHD*	*PR-HW*
GSC 98593	c55	40	17	42.5	c13	32.5	21
GSC 98599	c47	45	29	44.4	14	31.1	23
GSC 95577	c33	30	11.4	38	12	40	22

tation (Meister, 1989); the poorly preserved Queen Charlotte Islands material compares well with the densely ribbed varieties.

Occurrence.—*A. ruthenense* is a widely distributed Tethyan species reported from the circum-Mediterranean area (Wiedenmayer, 1977; Meister, 1989), British Columbia, and Oregon (Thomson and Smith, 1992). It characterizes the Upper Pliensbachian.

Localities.—I06, I14.

Age.—Kunae Zone (Late Pliensbachian).

Genus **LEPTALEOCERAS** Buckman, 1918

Naxeniceras Fucini, 1931, p. 147.
Distefania Fucini, 1931, p. 153.
Trinacrioceras Fucini, 1931, p. 157.
Seguentia Fucini, 1931, p. 122.
Ugdulenia Cantaluppi, 1970, p. 40.

Type species.—*Leptaleoceras leptum* Buckman, 1918, p. 284, pl. 26, figs. 1–3 by original designation.

Remarks.—Moderately evolute forms with a compressed oval whorl section bearing a keel flanked by smooth bands or sulci. Ribbing is dense and often sinuous. Detailed treatments of the genus are given by Wiedenmayer (1977) and Braga (1983).

Age and distribution.—Most species of this genus occur in the circum-Mediterranean area of the Tethyan Realm ranging through beds that correlate with the upper Margaritatus and Spinatum zones. Occurrences are also known in the northwest European Province, where the genus was first recognized (Buckman, 1918), Oregon (Imlay, 1968), British Columbia (Thomson and Smith, 1992), and Mexico (Erben, 1954). The genus is also questionably present in Argentina amongst material described as *Bouleiceras* sp. (Hillebrandt, 1973b), as discussed by Wiedenmayer (1980, p. 137).

Leptaleoceras aff. **accuratum** (Fucini, 1931)
Plate 22, figures 6, 8, 9

aff. *Arieticeras(?) accuratum* Fucini, 1931, p. 117, pl. 24, fig. 10.
Leptaleoceras pseudoradians (Reynès). Frebold, 1964a, p. 15, pl. 4; 1970, p. 443, pl. 2, fig. 2.
Leptaleoceras cf. *pseudoradians* (Reynès). Imlay, 1981, p. 40, pl. 11, figs. 12, 13.
Arieticeras cf. *domarense* (Meneghini). Imlay, 1981, p. 39, pl. 10, fig. 15 only.
Leptaleoceras accuratum (Fucini) morphotype "*preaccuratum*". Braga, 1983, p. 256, pl. 11, figs. 27–30, pl. 12, figs. 1, 2.
Leptaleoceras aff. *accuratum* (Fucini). Smith, Tipper, Taylor, and Guex, 1988, pl. 4, fig. 9; Thomson and Smith, 1992, p. 34, pl. 13, figs. 1–6.

Description.—Evolute with a compressed, ogival whorl section bearing a keel flanked by smooth areas or weak sulci at large diameters. Ribbing characteristically changes with growth. The nucleus is smooth; the middle whorls (up to umbilical diameters of approximately 15 mm) bear densely spaced, wiry, rectiradiate to gently rursiradiate ribs that project onto the venter; ribs on outer whorls are coarser, less densely spaced and slightly sinuous.

Type material.—Holotype: Fucini, 1931, pl. 8, fig. 10.

Material.—Twelve specimens, mostly external molds, in buff coloured sandstone of the upper Fannin Formation.

Measurements.—See Table 33.

Discussion.—This species is placed in *Leptaleoceras* rather than *Arieticeras* because of its very dense, sharp ribbing. The species is probably closely related to the densely ribbed *A. ruthenense* which is known from the Spatsizi area of north-central British Columbia (Thomson and Smith, 1992) as well as the Queen Charlotte Islands.

Occurrence.—*Leptaleoceras accuratum* is a circum-Mediterranean Tethyan species known from the Upper Pliensbachian of Italy, southern France, Spain, and southern Switzerland (Fucini, 1931; Wiedenmayer, 1980; Braga, 1983). It is also known from the Kunae Zone of North America as discussed by Thomson and Smith (1992).

Localities.—I17.

Age.—Kunae Zone (Late Pliensbachian).

Table 34.—Measurements of *Leptaleoceras compressum* (Monestier, 1934). All measurements are in mm.

specimen no.	*DM-AX*	*D*	*UD*	*U*	*WW*	*WWD*	*WH*	*WHD*	*WW-WH*	*PR-HW*
GSC 98601	28.5	25	11	44	6.2	24.8	8.2	32.8	75.6	21

Leptaleoceras compressum (Monestier, 1934)
Plate 22, figure 10

Arieticeras compressum Monestier, 1934, p. 51, pl. 8, figs. 21–23.
Arieticeras compressum var. *semilaevis* Monestier, 1934, p. 51, pl. 8, fig. 20.
non *Fuciniceras compressum* (Monestier). Fischer, 1975, p. 74, pl. 2, fig. 13, 14 (=*Leptaleoceras macrum*).
Fuciniceras aff. *compressum* (Monestier). Fischer, 1975, p. 76, pl. 2, fig. 15.
Leptaleoceras (Leptaleoceras) compressum (Monestier). Wiedenmayer, 1980, p. 118, pl. 22, figs. 6, 9.

Description.—Evolute, slowly expanding form bearing a low keel. The umbilical wall is low and steep, the

Table 35.—Measurements of *Leptaleoceras* sp. All measurements are in mm.

specimen no.	*DMAX*	*D*	*UD*	*U*	*WW*	*WWD*	*WH*	*WHD*	*WWWH*	*PRHW*
GSC 98602	c19	c17	c6	35.3	c4.3	25.3	6.5	38.2	66.2	c23
GSC 98604	25	25	9	36	6.3	25.2	9.3	37.2	67.7	22
GSC 99021	19	19	6.3	33.2	—	—	c7.5	39.5	—	c19
	—	—	3.5	—	3.3	—	5	—	66	—

flanks flat and the venter broadly arched giving an ogival whorl section. The densely spaced, narrow ribs are rectiradiate to gently rursiradiate and projected onto the venter. The whorls are smooth to an umbilical diameter of approximately 5 mm.

Type material.—Syntypes: Monestier, 1934, pl. 8, figs. 21–23.

Material.—One specimen from sandstone of the Fannin Formation.

Measurements.—See Table 34.

Discussion.—This species is included in the genus *Leptaleoceras* rather than *Arieticeras* because of its fine, dense ribbing. *L. compressum* differs from *L.* sp. with which it co-occurs in the Queen Charlotte Islands, by its smaller expansion rate (less than 2 compared to greater than 2), slightly coarser ribbing and its less sharp keel. The slowly expanding *L. macrum* (Monestier, 1934) which Meister (1989; under the generic name *Arieticeras*) considers a synonym of *L. compressum,* differs only in its finer, denser ribbing which arises early in ontogeny, contrasting with the larger, smooth nucleus of *L. compressum.*

Occurrence.—*L. compressum* is known from the Margaritatus Zone of southern France, southern Germany, and southern Switzerland (Monestier, 1934; Fischer, 1975; Wiedenmayer, 1980).

Locality.—I06.

Age.—Kunae Zone (Late Pliensbachian).

Leptaleoceras sp.
Plate 22, figures 7, 11–13
Text-figures 37e-f, 38m

Description.—Midvolute to evolute form with a compressed whorl section bearing a sharp keel. The ribs are fine, densely spaced and gently sinuous. At umbilical diameters greater than approximately 8 mm, the convex flanks flatten slightly and the ornamentation coarsens.

Material.—Twenty-two specimens in calcareous sandstone of the upper Fannin Formation.

Measurements.—See Table 35.

Discussion.—As noted above, *Leptaleoceras compressum* is more coarsely ribbed and slightly more evolute than *L.* sp. It is conceivable that all the specimens represent variants of the same species but *L.* sp. is much more common.

Localities.—DT1, D20, D23, FT2, F11(?), I06, I14.

Age.—Kunae Zone (Late Pliensbachian).

Genus **FONTANELLICERAS** Fucini, 1931

Type species.—*Harpoceras fontanellense* Gemmellaro, 1886 (p. 118, pl. 2, figs. 1, 2) by subsequent designation (Vecchia, 1949, p. 142). The type material has been refigured by Fucini (1931, pl. 24, figs. 21, 22).

Remarks.—Evolute, slowly expanding and stout whorled forms with sulcate keels and strong, simple ribs.

Age and distribution.—A Tethyan form known from the Upper Pliensbachian and lowermost Toarcian of Italy (Fucini, 1931; Cantaluppi and Brambilla, 1968; Fantini Sestini, 1977), southern Switzerland (Wiedenmayer, 1980), Spain (Braga, Jiminéz and Rivas, 1982; Braga, 1983), France (Monestier, 1934), Morocco (Guex, 1973), Japan (Hirano, 1971), and the United States (Imlay, 1968, 1981).

Fontanelliceras sp.
Plate 22, figures 1, 2

Description.—Evolute, slowly expanding form with a slightly compressed whorl section with convex flanks. The venter bears a prominent, weakly sulcate keel. Ribs are simple and coarse; they are rectiradiate to slightly rursiradiate on the flanks and project weakly onto the venter.

Material.—Two internal molds and several fragments preserved in calcareous sandstone of the Fannin Formation.

Measurements.—See Table 36.

Discussion.—These specimens show a resemblance to some forms collected from Alaska and figured under the name of *Fontanelliceras* cf. *fontanellense* by Imlay (1981, pl. 11, figs. 19 and 20). The remainder of Imlay's *F.* cf. *fontanellense* (1981, pl. 11, figs. 17, 18, 21–23) together with *Arnioceras?* sp. indet. of Frebold (1964a) appears to belong to *F. juliae* of Fucini (1931, pl. 8, figs. 28–31). The Queen Charlotte Islands specimens differ from *F. fontanellense* in being more compressed, more weakly sulcate and more coarsely ribbed.

Localities.—D20, D22, E52, I14.

Age.—Kunae Zone (Late Pliensbachian).

Table 36.—Measurements of *Fontanelliceras* sp. All measurements are in mm.

specimen no.	*D*	*UD*	*U*	*WW*	*WH*	*WW-WH*	*PR-HW*
GSC 98583	24	12	50	—	—	—	10
	—	8	—	4.7	5.2	90.4	—

Genus CANAVARIA Gemmellaro, 1886

Type species.—*Harpoceras (Dumortieria) haugi* Gemmellaro, 1886, pl. 1, figs. 1–3 by subsequent designation (Howarth, 1955, p. 167).

Remarks.—Evolute, slowly expanding forms with a subrectangular whorl section. A keel is present flanked by smooth areas or weak sulci. The ribbing is simple, straight to weakly sinuous, with tubercules on the ventral ends. This genus is closely related to the non-tuberculate *Emaciaticeras* and the bituberculate *Tauromeniceras* both of which have been included as subgenera of *Canavaria* by some workers (Wiedenmayer, 1980; Braga, 1983).

Age and distribution.—*Canavaria* is a circum-Mediterranean form characteristic of the upper part of the Pliensbachian (the Emaciatum Zone in Spain [Braga, 1983] and upper Spinatum Zone equivalents). Material from Oregon referred to *Canavaria* by Imlay (1968) has subsequently been referred to the genus *Oregonites* (Wiedenmayer, 1980) which resembles *Fontanelliceras* except for the irregularity of the ornamentation. *Canavaria* is questionably present in the Spatsizi area of northern British Columbia (Thomson and Smith, 1992).

Canavaria? sp.
Plate 21, figure 5

Description.—An evolute (U=c60) slowly expanding form bearing a sulcate keel. The coarse ribs, which reach a density of approximately 23 per half whorl on the outer whorl, are simple and rursiradiate with their ventral ends swollen. Poorly preserved traces of the septal suture are evident up to the last half whorl.

Material.—One compressed and slightly distorted internal mold preserved in noncalcareous sandstone of the Fannin Formation.

Discussion.—This isolated specimen was collected from an outcrop in an otherwise covered stratigraphic interval on Maude Island situated between sandstones yielding a Carlottense Zone fauna and sandstones yielding a Kunae Zone fauna. The specimen does show the important morphological features of the genus but its poor preservation, the uncertainty of its stratigraphic position, and the fact that this genus is not unequivocally known from any other locality in North America all leave room for doubt as to its true affinity.

Table 37.—Measurements of *Oregonites? dawsoni,* new species. All measurements are in mm.

specimen no.	*DM-AX*	*D*	*UD*	*U*	*WW*	*WWD*	*WH*	*WHD*	*WW-WH*	*PR-HW*
GSC 98727	c25	c25	8.8	35.2	7.3	29.2	8	32	91.3	11

Occurrence.—This specimen occurred in sandstones lithologically similar and geographically fairly close to those yielding a Carlottense Zone fauna. There is no associated fauna, however, to confirm this assignment.

Locality.—E61.

Age.—Probably Late Pliensbachian.

Genus OREGONITES Wiedenmayer, 1980

Type species.—*Oregonites imlayi* Wiedenmayer, 1980=*Canavaria* cf. *C. morosa* of Imlay, 1968, p. 35, pl. 5, figs. 12–14 (Wiedenmayer, 1980, p. 124).

Remarks.—Evolute with depressed whorl sections bearing a keel that is simple or flanked either by smooth areas or narrow sulci. Ribs are strong, rursiradiate, sometimes irregularly paired near the umbilical margin. Species of *Fontanelliceras* are more evolute and more regularly ribbed; species of *Arieticeras* have simpler, more rectiradiate ornamentation and whorls that in most cases are more compressed. Many of the species Wiedenmayer (1980) tentatively assigned to *Oregonites,* however, are better accommodated in these genera. The exceptions are Imlay's (1968) species *Fuciniceras* sp. A, *F.* sp. B, *F.* cf. *capellinii,* and *F.* cf. *inclytum.*

Age and distribution.—From the Upper Pliensbachian of North America.

Oregonites? dawsoni, new species
Plate 20, figure 13

Description.—Midvolute, slightly compressed form with an arched venter bearing a sharp keel that is simple where the shell is preserved but flanked by incipient sulci on the internal mold. The specimen is incomplete but the outer half whorl is non-septate and the last quarter whorl shows a decline in the ornament and strength of the keel. The inclined umbilical wall rounds evenly into the gently convex flanks.

The ribs arise near the umbilical shoulder and are strongest on the flanks where they arch backward. The ribs project onto the venter from the ventro-lateral area but they fade and rapidly disappear.

Type material.—Holotype: GSC 98727 (Pl. 20, fig. 13). Preserved in calcareous sandstone of the upper Fannin Formation.

Measurements.—See Table 37.

Derivation of name.—After G.M. Dawson, a pioneer

Canadian geologist who undertook reconnaissance work in the Queen Charlotte Islands during the 19th century.

Discussion.—The stout whorl shape compared with other Pliensbachian hildoceratids, the markedly rursiradiate ribs and the distinct keel are characteristic of the genus *Oregonites* but the assignment to this genus is tentative because the specimen is more involute, more compressed and more regularly ribbed than the forms normally accommodated within *Oregonites.* It is most similar to *Fuciniceras* sp. B, an as yet unnamed species from Oregon described by Imlay (1968) and assigned to *Oregonites* by Wiedenmayer (1980). It differs by having a more compressed whorl section, a more arched venter and ribs that disappear at the ventro-lateral area. In an earlier work (Smith *et al.*, 1988), *O.? dawsoni* was provisionally compared to *"Grammoceras" sygma* Monestier (1934) and assigned to *Fieldingiceras* but Monestier's material from the Margaritatus Zone does not have the distinct keel of *O.? dawsoni.*

Occurrence.—*O.? dawsoni* is unfortunately only known from this single specimen from the Queen Charlotte Islands.

Locality.—E63.

Age.—Carlottense Zone (Late Pliensbachian).

Subfamily **HARPOCERATINAE** Neumayr, 1875

Genus **FIELDINGICERAS** Wiedenmayer, 1980

Fieldingia Cantaluppi, 1970, p. 41.
Grammoceratoides Mattei, 1967, p. 556.

Type species.—*Ammonites fieldingii* Reynès, 1868, p. 97, pl. 4, fig. 1.

Remarks.—Evolute compressed forms that are fairly small and have a sharp keel. Meister (1986) has suggested that *Fieldingiceras* might represent microconchs of *Protogrammoceras.* Smooth and irregularly ribbed forms are known and some workers hold that the costate *F. fieldingii* and the smooth *F. pseudofieldingii* are variants of the same species (Imlay, 1968; Braga, 1983). They are kept separate here because they do not always co-occur at the same locality or within the same geographic area.

This genus was first called *Fieldingia* by Cantaluppi (1970) but Wiedenmayer (1980, p. 128) pointed out that this name is a junior homonym of the hexactinellid sponge *Fieldingia* Kent (1870). Rather than giving Cantaluppi the opportunity to select a new name, Wiedenmayer (1980) simply renamed Cantaluppi's genus *Fieldingiceras.*

Age and distribution.—Characteristic of the Margaritatus Zone of the circum-Mediterranean area. In North America, *Fieldingiceras* is presently known from northern British Columbia and eastern Oregon. Frebold (1964a) figured a ribbed form (Ammonite gen. and sp. indet. 2, pl. 2, fig. 10) from the Telegraph Creek area, British Columbia, that is similar to, if not conspecific with, *Fieldingiceras morganense* reported from the Nicely Formation of eastern Oregon by Imlay (1968). Imlay also recorded a single specimen from the Nicely Formation tentatively assigned to *F. pseudofieldingii.*

Fieldingiceras fieldingii (Reynès, 1868)
Plate 20, figure 14; Plate 21, figure 3;
Text-figure 37c

Ammonites Fieldingii Reynès, 1868, p. 97, pl. 4, fig. 1.
Harpoceras? Fieldingii Reynès. Fucini, 1901a, p. 51, pl. 7, fig. 8.
Grammoceras Fieldingii (Reynès). Monestier, 1934, p. 33, pl. 4, figs. 30, 38, 39 only.
Leptaleoceras (Fieldingia) fieldingii (Reynès). Wiedenmayer, 1980, p. 123, pl. 23, figs. 29, 30.
aff. *Fieldingia* aff. *fieldingii* (Reynès). Mouterde and Rocha, 1981, p. 218, pl. 2, figs. 3–6.
Fieldingiceras fieldingii (Reynès). Braga, 1983, p. 181, pl. 7, figs. 3, 4, 6–11; Meister, 1986, pl. 22, fig. 4.
Fieldingiceras gr. *fieldingii* (Reynès). Dommergues, Ferretti, Géczy, and Mouterde, 1983, p. 479, pl. 2, figs. 15–20.
Protogrammoceras (Fieldingiceras) fieldingii (Reynès). Meister, 1989, p. 40, pl. 4, figs. 2, 3, 5.

Description.—Midvolute, with a compressed whorl section bearing a pronounced, simple keel. The outer half whorl of specimen GSC 98728 is non-septate, egresses and shows a weakening of the keel and ornamentation. The last few ribs are approximated and the peristome flares slightly and projects ventrally. These features indicate that this form is mature.

The ribs arise near the umbilical shoulder, are rursiradiate on the flanks and project onto the venter where they fade rapidly. On the outer quarter whorl of specimen GSC 98728, weak ribs can be seen in oblique light projecting forward strongly onto and over the venter where the keel is weakening.

Type material.—Holotype: Reynès, 1868, pl. 4, fig. 1.

Material.—Two specimens in sandstone of the upper Fannin Formation.

Measurements.—See Table 38.

Occurrence.—From the Margaritatus Zone of Italy (Fucini, 1904; Dommergues *et al.*, 1983), southern France (Monestier, 1934), southern Switzerland (Wiedenmayer, 1980), and Spain (Braga, 1983).

Locality.—ET5.

Age.—Not in place but originating from the Carlottense Zone (Late Pliensbachian).

Fieldingiceras pseudofieldingii (Fucini, 1904)
Plate 21, figures 1, 4; Plate 22, figures 3–5
Text-figures 37g, 38n

Harpoceras(?) pseudofieldingii Fucini, 1904, p. 251, pl. 41, fig. 4.

Table 38.—Measurements of *Fieldingiceras fieldingii* (Reynès, 1868). All measurements are in mm.

specimen no.	*DMAX*	*DPHRAG*	*D*	*UD*	*U*	*WW*	*WWD*	*WH*	*WHD*	*WWWH*	*PRHW*
GSC 98728	19	c14	19	6.5	34.2	5.5	28.9	6.5	34.2	84.6	10

Praeleioceras pseudofieldingii (Fucini). Fucini, 1931, p. 108, pl. 22, figs. 12, 13.
Grammoceras penenudum Monestier, 1934, p. 41, pl. 4, figs. 9–16; pl. 8, figs. 28, 29.
Grammoceras intermediate between *fieldingii* and *pseudofieldingii* Monestier, 1934, p. 36, pl. 4, figs. 22, 23.
Grammoceras pseudofieldingii (Fucini). Monestier, 1934, p. 35, pl. 4, figs. 24–26.
Protogrammoceras? cf. *P.? pseudofieldingi* (Fucini). Imlay, 1968, p. C40, pl. 7, figs. 5–7.
Leptaleoceras (Fieldingia) pseudofieldingi (Fucini). Wiedenmayer, 1980, p. 123, pl. 23, fig. 31.
Fieldingiceras fieldingii (Fucini). Braga, 1983, p. 181, pl. 7, fig. 5 only.

Description.—Evolute with a compressed whorl section bearing a sharp keel on an arched venter. The umbilical wall is low and steep and the flanks flat. The shell is smooth except for barely visible, radially arranged and ventrally projected striations.

Type material.—Holotype: Fucini, 1904, pl. 41, fig. 4.

Material.—Six specimens preserved in calcareous sandstone of the upper Fannin Formation.

Measurements.—See Table 39.

Discussion.—This form differs from the nuclei of associated species of *Arieticeras* by its compressed whorls and lack of ornamentation to relatively large shell diameters.

Occurrence.—In western Europe *Fieldingiceras pseudofieldingii* is a Tethyan species known from Italy (Fucini, 1904), southern France (Monestier, 1934), southern Switzerland (Wiedenmayer, 1980), and Spain (Braga, 1983) where it characterizes the lower Margaritatus Zone and its equivalents.

Localities.—D19, D20, FT2, I06, I07.

Age.—Kunae Zone (Late Pliensbachian).

Genus **FUCINICERAS** Haas, 1913

Eofuciniceras Cantaluppi, 1970, p. 41.
Neofuciniceras Cantaluppi, 1970, p. 41.

Type species.—*Harpoceras lavinianum* Meneghini *in* Fucini, 1900, pl. 11, figs. 6 and 7, by original designation (Haas, 1913, p. 75).

Table 39.—Measurements of *Fieldingiceras pseudofieldingii* (Fucini, 1904). All measurements are in mm.

specimen no.	*DMAX*	*D*	*UD*	*U*	*WW*	*WWD*	*WH*	*WHD*	*WW-WH*
GSC 98587	c24	17 1	6.5	38.2	—	—	6.5	38.2	—
GSC 98590	15.4	14.8	5.7	38.5	3.8	25.7	5.8	39.2	65.5
GSC 99018	13.8	13.4	4.6	34.3	3.5	26.1	5.2	38.8	67.3

Remarks.—When Spath (1913) first recognized the genus *Protogrammoceras* he included a group whose ribs did not project onto the venter as was typical of *Protogrammoceras.* Unbeknownst to Spath, this group had been independently recognized by Haas (1913) and named *Fuciniceras. Fuciniceras* may also be distinguished from *Protogrammoceras* by its less sinuous ribbing which is rursiradiate on the upper flank and the tendency to have a flat, bisulcate venter; otherwise the genera are very similar and obviously closely related.

Age and distribution.—As with *Protogrammoceras, Fuciniceras* is widely distributed but most abundant and diverse in the Tethyan Realm. It is restricted to the Pliensbachian, ranging from the upper Ibex Zone into the Margaritatus Zone (Géczy, 1976; Wiedenmayer, 1977, 1980; Meister, 1986).

Fuciniceras cf. **targionii** (Fucini, 1905)
Plate 22, figures 14, 15

cf. *Hildoceras Targionii* Fucini, 1905, p. 271, pl. 44, fig. 1.
Fuciniceras cf. *targionii* (Fucini). Wiedenmayer, 1980, p. 85, pl. 11, figs. 6, 7.

Description.—Midvolute, moderately slowly expanding form with what appears to have been a subquadrate, compressed whorl section. The umbilical wall is high and rounds rapidly into the flat flanks. The venter bears a pronounced, sulcate keel. The nucleus of GSC 98606 (Pl. 22, fig. 14) appears to be smooth but the ribbing on the rest of the whorls is weak on the lower flank becoming increasingly stronger and rursiradiate on the upper flank. The sinuous trace of a former aperture followed by subdued ornamentation is evident in specimen GSC 98609 (Pl. 22, fig. 15).

Type material.—Holotype: Fucini, 1905, pl. 44, fig. 1.

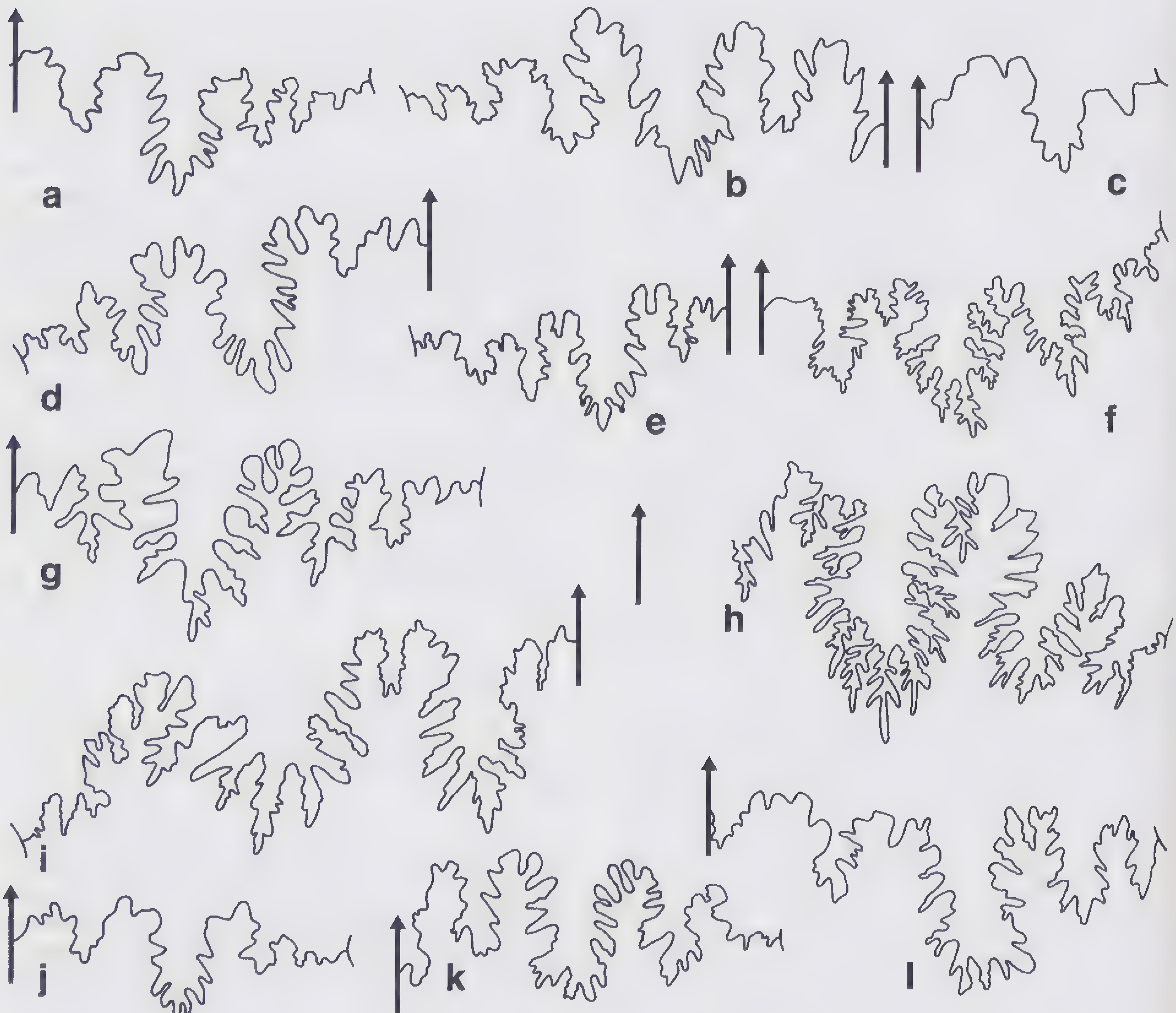
Material.—Two poorly preserved, partial internal molds in siltstone of the Fannin Formation.

Discussion.—The distinctive ornamentation of the Queen Charlotte Islands material compares well with the figured material of *F. targionii.* The ventral features and whorl shape also appear to correspond, as far as preservation permits comparison.

Occurrence.—*F. targionii* occurs in Italy (Fucini, 1905) and the Davoei Zone of Switzerland (Wiedenmayer, 1980).

Locality.—I17.

Age.—Kunae Zone (Late Pliensbachian).



Text-figure 38.—Traces of the septal suture for species of the Hildoceratidae at whorl heights (WH) indicated. a. *Lioceratoides (Pacificeras) propinquum* (Whiteaves, 1884) (GSC 87806, WH = 11 mm); b. *Protogrammoceras (Protogrammoceras) aequiondulatum* (Bettoni, 1900) (GSC 98649, WH = 14.3 mm); c. *Fuciniceras* aff. *intumescens* (Fucini, 1901) (GSC 87801, WH = 6.2 mm); d-g. *Lioceratoides (Pacificeras) propinquum* (Whiteaves, 1884) (d. GSC 98690, WH = 5.2 mm, e. GSC 98685, WH = 10.7 mm, f. GSC 98687, WH = 17.6 mm, g. GSC 87804, WH = 15.2 mm); h. genus and species indet. (GSC 99013, WH = 41.1 mm); i. *Protogrammoceras (Protogrammoceras) skidegatense,* n. sp. (Paratype GSC 98741, WH = 49.8 mm); j. *Protogrammoceras (Protogrammoceras)*? sp. (GSC 98744, WH = 7.9 mm); k,l. *Protogrammoceras (Protogrammoceras)* cf. *paltum* (Buckman, 1922) (k. GSC 99017, WH = 11.1 mm, l. GSC 99015, WH = 20.9 mm); m. *Leptaleoceras* sp. (GSC 98602, WH = 4.5 mm); n. *Fieldingiceras pseudofieldingii* (Fucini, 1904) (GSC 98590, WH 3.3. mm); o. *Arieticeras disputabile* (Fucini, 1908) (GSC 98719, WH = 4 mm).

Fuciniceras aff. **intumescens**
(Fucini, 1901)
Plate 22, figure 16, Text-figure 39j

aff. *Hildoceras intumescens* Fucini, 1901a, p. 89, pl. 13, fig. 3; 1905, p. 271, pl. 43, fig. 15.
aff. *Fuciniceras? intumescens* (Fucini). Venzo, 1952, pl. A, fig. 3.
non *Arieticeras intumescens* (Fucini). Cantaluppi and Savi, 1968, p. 246, pl. 21, fig. 6.
Fuciniceras? cf. *intumescens* (Fucini). Imlay, 1968, p. C42, pl. 8, figs. 1–7, 9, 10.
Fuciniceras aff. *intumescens* (Fucini). Smith, Tipper, Taylor, and Guex, 1988, pl. 4, fig. 14.

Description.—Evolute, slowly expanding shell with a compressed, elliptical whorl section bearing a simple keel. The ribs project forward on the lower part of the flank and then trend more rursiradiately on the upper flank; they are only weakly projected onto the venter where they quickly fade.

Type material.—Holotype of *Fuciniceras intumescens*: Fucini, 1901a, pl. 13, fig. 3.

Material.—Eight specimens from the upper sandstone of the Fannin Formation.

Discussion.—This material is reminiscent of specimens collected from the Nicely Formation in Oregon and compared with *F. intumescens* by Imlay (1968). The type specimen of *F. intumescens* is less compressed.

Occurrence.—*F. intumescens* is known from the Upper Pliensbachian of Italy. *F.* aff. *intumescens* is reported from the Upper Pliensbachian of Oregon (Imlay, 1968).

Localities.—E52, E60, I06.

Age.—Kunae Zone (Late Pliensbachian).

Fuciniceras sp.
Plate 21, figures 6, 7

Description.—These midvolute specimens have a compressed whorl section. The steep umbilical wall rounds quickly into the flanks that are subparallel in their lower and middle parts and thereafter convergent towards the venter. On the smaller specimen (Pl. 21, fig. 7) the prominent keel is bordered by incipient sulci. The larger specimen has a less well preserved venter but the keel was evidently flanked by deep sulci producing an almost tricarinate effect.

The ribs are coarse. They are weakest near the umbilicus where they are gently prorsiradiate but increase in strength near the mid-flank where there is an inflection. The ribs trend rursiradiately across the upper flank (markedly in the larger specimen figured on Plate 21, fig. 6) and begin to project toward the venter but terminate against the sulci.

Material.—Two incomplete specimens originating from the sandstones of the Fannin Formation.

Discussion.—These fragments are assigned to *Fuciniceras* because of the backward inflection of the ribs on the upper flank and the presence of a sulcate keel. Their strong ribs are reminiscent of species such as *Fuciniceras targionii* (Fucini) and *F. lavinianum* (Fucini).

Locality.—FT2.

Age.—Associated with ammonites of the Kunae Zone (Late Pliensbachian).

Genus **PROTOGRAMMOCERAS** Spath, 1913

Subgenus **PROTOGRAMMOCERAS** Spath, 1913

Wrightia Gemmellaro, 1886, p. 190.
Paltarpites Buckman, 1922, pl. 362A.
Argutarpites Buckman, 1923, pl. 363.
Bassaniceras Fucini, 1929, p. 63.
Eoprotogrammoceras Cantaluppi, 1970, p. 42.
Neoprotogrammoceras Cantaluppi, 1970, p. 42.

Type species.—*Grammoceras bassanii* Fucini, 1901a, p. 72, pl. 10, fig. 6 by subsequent designation (Spath, 1919, p. 547). The type material has been refigured by Cantaluppi (1972).

Remarks.—Midvolute forms with an ogival or compressed elliptical whorl section and a strongly carinate venter that is sometimes bisulcate. Ribs are sinuous and projected onto the venter. We agree with Howarth (1973) who points out that there is no difference between the type material of *Protogrammoceras* and *Paltarpites* worthy of generic distinction.

Age and distribution.—*Protogrammoceras (Protogrammoceras)* has a wide distribution but is at its most abundant and diverse in the circum-Mediterranean area within the Tethyan Realm. It ranges from the Lower Pliensbachian (Ibex Zone) to the basal Toarcian.

Protogrammoceras (Protogrammoceras)
aequiondulatum (Bettoni, 1900)
Plate 24, figures 7–9; Text-figures 38b, 39f,t

Harpoceras? aequiondulatum Bettoni, 1900, p. 67, pl. 6, fig. 11.
Grammoceras aequiondulatum Bettoni. Del Campana, 1900, p. 625, pl. 8, fig. 32.
Harpoceras aequiondulatum Bettoni. Fucini, 1908b, p. 39, pl. 2, figs. 46, 47.
Harpoceras percostatum Fucini, 1908b, p. 37, pl. 1, fig. 29.
Protogrammoceras aequiondulatum (Bettoni). Fucini, 1924, p. 61, pl. 7, figs. 12; Wiedenmayer, 1980, p. 85, pl. 11, figs. 8, 9; Braga, 1983, p. 161, pl. 5, figs. 3–5.
Protogrammoceras? percostatum (Fucini). Fucini, 1924, p. 57, pl. 8, fig. 1.
Neoprotogrammoceras aequiondulatum (Bettoni). Ferretti, 1972, p. 116, pl. 15, fig. 3.
(?)*Argutarpites* cf. *Aequiondulatum* (Bettoni). Dubar and Mouterde, 1978, p. 63.
Protogrammoceras percostatum (Fucini). Wiedenmayer, 1980, p. 88, pl. 12, figs. 10–12.

Table 40.—Measurements of *Protogrammoceras* (*Protogrammoceras*) *aequiondulatum* (Bettoni, 1900). All measurements are in mm.

specimen no.	*DMAX*	*D*	*UD*	*U*	*WW*	*WWD*	*WH*	*WHD*	*WWWH*	*PRHW*
GSC 98649	—	—	c21	—	25	—	47	—	53.2	—
	—	—	8	—	—	—	—	—	—	23
GSC 98734	c42	35	10	28.6	c8.5	24.3	15.5	44.3	c54.8	24
GSC 98735	28.5	28.5	18	28.1	7.4	26.0	12.2	42.8	60.7	24

Description.—An involute, rapidly expanding form with compressed whorls. The umbilical wall is low, the flanks flat to weakly convex, and the narrow venter is arched. The ribs are simple, sinuous and strongly projected onto the venter. Rib frequencies are high with a tendency for the ribs to become flat-topped with growth.

Type material.—Holotype: Bettoni, 1900, pl. 6, fig. 11.

Material.—Five specimens and numerous fragments preserved in calcareous sandstone of the upper Fannin Formation.

Measurements.—See Table 40.

Discussion.—Most of the figured specimens of *Protogrammoceras (P.) aequiondulatum* are small, of the diameter of the specimens illustrated as figures 7 and 9 on Plate 24. The larger specimen (Pl. 24, fig. 8) shows that ribbing style changes with growth to resemble the similarly involute species *Protogrammoceras percostatum* which is recognized as a subjective junior synonym by Braga (1983).

P. (P.) aequiondulatum is more involute and rapidly expanding than other species of *Protogrammoceras* found in the Queen Charlotte Islands with the exception of *P. (P.)?* sp. which is more coarsely ribbed.

Occurrence.—*P. (P.) aequiondulatum* is a Tethyan species found in Italy, Spain, and possibly Morocco where it is characteristic of the Upper Pliensbachian (Dubar and Mouterde, 1978; Wiedenmayer, 1980; Braga, 1983).

Localities.—B06, ET5, E62, E63.

Age.—Carlottense Zone (Late Pliensbachian).

Protogrammoceras (Protogrammoceras)? sp.
Plate 23, figures 1–3; Text-figures 38j, 39c

Harpoceras cf. *exaratum* (Young and Bird). Frebold, 1964a, p. 16, pl. 6, fig. 3 only.

Description.—Midvolute to involute, rapidly expanding forms with a compressed whorl section. The umbilical wall rounds rapidly into the gently convex flanks that converge weakly towards the venter that bears a simple, pronounced, blunt keel. Ornamentation is strong throughout growth and falcoid in trend. Where the ribs project onto the venter on some parts of the shell, short and much weaker intercalated ribs are present.

Material.—Three specimens preserved in calcareous sandstone of the upper Fannin Formation.

Measurements.—See Table 41.

Discussion.—These forms possibly belong to the genus *Protogrammoceras* on the basis of the trajectory of their simple ribs. Ribbing is quite strong and although there are parallels, such as in *Protogrammoceras celebratum,* the Queen Charlotte material is notably more involute.

Localities.—ET5, E62, E63.

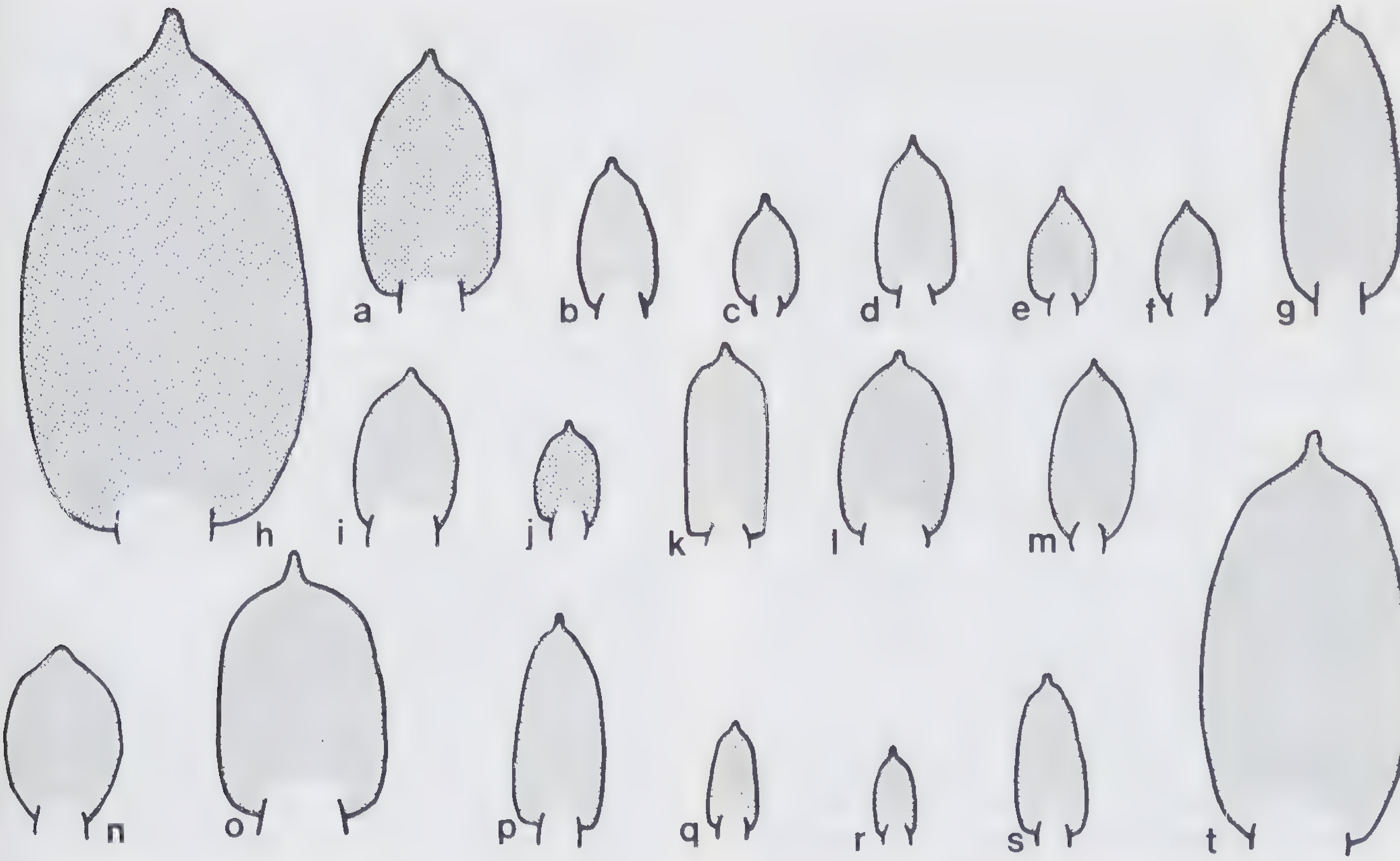
Age.—Carlottense Zone (Late Pliensbachian).

Protogrammoceras (Protogrammoceras) kurrianum
(Oppel, 1862)
Plate 24, figures 5, 6; Text-figure 39g

Ammonites kurrianus Oppel, 1862, p. 136, pl. 42, fig. 3; Quenstedt, 1883, p. 421, pl. 53, fig. 12.
Argutarpites argutus Buckman, 1923, pl. 363.
Harpoceras densecapillatum Fucini, 1924, p. 53, pl. 6, figs. 12, 13.
Polyplectus kurrianus (Oppel). Monestier, 1934, p. 90, pl. 5, figs. 12, 23; pl. 10, figs. 1, 17; pl. 11, figs. 3, 22.
Paltarpites cf. *argutus* (Buckman). Imlay, 1968, p. 37, pl. 5, figs. 20–22, 24, 25.
Paltarpites argutus (Buckman). Frebold, 1970, p. 444, pl. 4, figs. 8–10; Hillebrandt, 1987, pl. 5, fig. 2.
Protogrammoceras cf. *P. argutum* (Buckman). Imlay, 1981, p. 41, pl. 11, fig. 14.
Paltarpites sp. Pérez, 1982, pl. 19, fig. 6.
Protogrammoceras pectinatum (Meneghini, 1881). Smith, Tipper, Taylor, and Guex, 1988, pl. 5, fig. 12.

Table 41.—Measurements of *Protogrammoceras* (*Protogrammoceras*) sp. All measurements are in mm.

specimen no.	*DMAX*	*DPHRAG*	*D*	*UD*	*U*	*WW*	*WWD*	*WH*	*WHD*	*WWWH*	*PRHW*
GSC 98745	26.0	—	26.0	5.7	21.9	7.7	29.6	12.5	48.1	61.6	17
GSC 98744	27.0	—	27.0	6.0	22.2	—	—	12.6	45.2	—	21
GSC 99016	c41.0	—	35.0	9.4	26.9	9.0	25.7	15.0	42.9	60.0	17



Text-figure 39.—Whorl shape cross-sections for species of the Harpoceratinae. Figures are natural size. a,s. *Lioceratoides (Lioceratoides) allifordense* (McLearn, 1930) (a. GSC 98736, s. GSC 98641); b,d,e. *Protogrammoceras (Protogrammoceras)* cf. *paltum* (Buckman, 1922) (b. GSC 99017, d. GSC 98697, e. GSC 98746); c. *Protogrammoceras (Protogrammoceras)*? sp. (GSC 98745); f,t. *Protogrammoceras (Protogrammoceras) aequiondulatum* (Bettoni, 1900) (f. GSC 98735, t. GSC 98649); g. *Protogrammoceras (Protogrammoceras) kurrianum* (Oppel, 1862) (GSC 87808); h. *Protogrammoceras (Protogrammoceras) skidegatense*, n. sp. (Paratype GSC 98739); i. *Protogrammoceras (Matteiceras)* cf. *diornatum* Domergues et al., 1985 (GSC 99014); j. *Fuciniceras* aff. *intumescens* (Fucini, 1901) (GSC 87801); k,o. *Lioceratoides (Pacificeras) angonius* (Fucini, 1931) (k. GSC 98611, o. GSC 98732); l,m. *Tiltoniceras antiquum* (Wright, 1882) (l. GSC 98731, m. GSC 98716); n,q. *Lioceratoides (Pacificeras) propinquum* (Whiteaves, 1884) (n. GSC 87804, q. GSC 87806); p. *Lioceratoides (Lioceratoides) involutum*, n. sp. (Paratype GSC 98644); r. *Lioceratoides* sp. juv. (GSC 98642).

Protogrammoceras (Paltarpites) kurrianus (Oppel, 1862). Meister, 1989, p. 41, pl. 8, figs. 1, 2.

Protogrammoceras (Protogrammoceras) kurrianum (Oppel). Howarth, 1992, p. 60, pl. 3, figs. 2, 3.

Description.—Midvolute form with a compressed whorl section. The umbilical wall is low and the flanks weakly convex, converging towards a narrow venter bearing a high, simple keel. Ornamentation is fine and dense having a flat-topped appearance on most larger whorls. The largest specimen in the collection is incomplete but had an estimated diameter of at least 200 mm. Its last quarter whorl, which is apparently nonseptate, is very weakly and densely ribbed. All ribs have a sinuous trend with a strong projection onto the venter.

Type material.—Holotype: Oppel, 1862, fig. 3. Refigured by Fischer (1975, pl. 2, fig. 5) and Schlegelmilch (1976, pl. 42, fig. 5).

Material.—Six incomplete specimens preserved in calcareous sandstone of the upper Fannin Formation.

Measurements.—See Table 42.

Discussion.—According to Howarth (1992), *P. (P.) kurrianum* is a senior subjective synonym of *P. (P.) argutum* (Buckman) and *P. (P.) densecapillatum* (Fucini). *P. (P.) kurrianum* is more evolute and slowly expanding than other species of *Protogrammoceras* from the Queen Charlotte Islands with the exception of *P. (P.)?* sp. whose ribs are coarser, less densely spaced and strongest on the upper part of the flank.

Occurrence.—*Protogrammoceras (P.) kurrianum* is widely distributed in Europe where it is characteristic of Margaritatus and Spinatum zones. In the Americas it is known from the Upper Pliensbachian of Chile (Pérez, 1982; Hillebrandt, 1987), Oregon (Imlay, 1968), northern British Columbia (Frebold, 1970; Thomson and Smith, 1992), and Alaska (Imlay, 1981).

Table 42.—Measurements of *Protogrammoceras* (*Protogrammoceras*) *kurrianum* (Oppel, 1862). All measurements are in mm.

specimen no.	*DMAX*	*D*	*UD*	*U*	*WW*	*WWD*	*WH*	*WHD*	*WWWH*	*PRHW*
GSC 87808	c90	84	24	28.6	c17	20.2	34.3	40.8	49.6	38
	–	–	15	–	–	–	–	–	–	36
GSC 98733	c73	c70	21.5	30.7	–	–	–	–	–	c44
	–	–	10	–	–	–	–	–	–	23

Localities.—D24, ET5, E67, E68.

Age.—Carlottense Zone (Late Pliensbachian).

Protogrammoceras (Protogrammoceras) cf. **paltum** (Buckman, 1922)

Plate 24, figures 1–4; Text-figures 38k-l, 39b,d,e

cf. *Paltarpites paltus* Buckman, 1922, pl. 362A.
Harpoceras cf. *exaratum* (Young and Bird). Frebold, 1964a, p. 16, pl. 6, figs. 1, 5.
Paltarpites paltus Buckman. Frebold, 1970, p. 443, pl. 4, figs. 5–7.
Protogrammoceras cf. *P. paltum* (Buckman). Imlay, 1981, p. 41, pl. 12, figs. 11, 12.
cf. *Protogrammoceras (P.) paltum* Buckman. Howarth, 1992, p. 57, pl. 1, figs. 1–3; pl. 2, figs. 1,3; Text-figure 11.

Description.–The specimens available are small, incomplete individuals that are midvolute (U=c25) with compressed whorls bearing broad sinuous ribs that project onto the venter where there is a pronounced, simple keel.

Type material.—Holotype: Buckman, 1922, pl. 362A.

Material.—Fourteen specimens preserved in calcareous sandstone of the upper Fannin Formation.

Discussion.—Because of their small size, it is difficult to identify these specimens with confidence. They are similar to other poorly preserved specimens from the Upper Pliensbachian of North America that have been compared with *P. paltum* in the past (Frebold, 1970; Imlay, 1981; Thomson and Smith, 1992).

Occurrence.—*Protogrammoceras (P.) paltum* is widespread in Europe, particularly in the south, where it ranges in age from the Margaritatus Zone into the basal Toarcian (Howarth, 1992). In North America it has been reported from the Upper Pliensbachian of northern British Columbia (Frebold, 1970; Thomson and Smith, 1992), Alaska (Imlay, 1981), and Arctic Canada (Hall and Howarth, 1983). The species has not yet been recorded from the conterminous United States or South America.

Localities.—D24-D27, ET5, E62, E63, E65, E66, I03.

Age.—Carlottense Zone (Late Pliensbachian) to early Toarcian.

Protogrammoceras (Protogrammoceras) skidegatense, new species

Plate 25, figures 1–3; Text-figures 38i, 39h

Paltarpites sp. indet. Sey and Kalacheva, 1980, p. 69, pl. 3, figs. 1, 2(?).

Description.—This species reaches a large size as illustrated in Plate 25, figure 3. The largest specimen in the collection, which is incomplete and almost wholly septate, reaches an estimated shell diameter of 260 mm. The shell is midvolute and rapidly expanding with a compressed whorl section. The umbilical wall is low and rounded, the flanks flat, and the narrow venter bears a prominent keel.

Ornamentation is strongest on the inner whorls where it consists of broad flat-topped to weakly rounded ribs that are prorsiradiate on the lower flank but arch backward on the upper flank; they project strongly onto the venter. At umbilical diameters of about 20 mm, the ribbing weakens, increases in density and is notably flat-topped. Large whorls, which show some indication of egression, are smooth.

Type material.—Holotype: specimen GSC 98740 (Pl. 25, fig. 2). Paratypes: specimens GSC 98739 (Pl. 25, fig. 3) and GSC 98741 (Pl. 25, fig. 1).

Material.—Nine specimens preserved in calcareous sandstone of the upper Fannin Formation.

Measurements.—See Table 43.

Derivation of name.—From Skidegate Inlet, separating Moresby and Graham islands, where the specimens originate.

Discussion.—This species is included in *Protogrammoceras* rather than *Lioceratoides* because its ribbing is consistently simple. The weakness and density of the ribbing on the outer whorls are reminiscent of *Protogrammoceras kurrianum* (a synonym of *P. argutum*) and allied forms which some workers assign to the genus or subgenus *Paltarpites*. The rapidly expanding,

Table 43.—Measurements of *Protogrammoceras* (*Protogrammoceras*) *skidegatense*, new species. All measurements are in mm.

specimen no.	*DMAX*	*UD*	*WW*	*WH*	*WWWH*	*PRHW*
GSC 98739	c190	46	35.3	60.4	58.4	0
	–	28	23	42	54.8	–
	–	9	–	–	–	20
GSC 98740	c125	37	c26.5	c46	57.6	–
	–	14	–	–	–	35
GSC 98741	c135	41	c30	59.4	c50.5	–
	–	17	–	–	–	c26

fairly involute and compressed shell together with the change of ribbing styles during ontogeny, however, set *P. skidegatense* apart from all these species.

Occurrence.—In North America this species is only presently known from the Queen Charlotte Islands where it is restricted to the Carlottense Zone. It is also known from the uppermost Pliensbachian of eastern Russia (Sey and Kalacheva, 1980).

Localities.—D24, D25, E63.

Age.—Carlottense Zone (Late Pliensbachian).

Subgenus **MATTEICERAS** Wiedenmayer, 1980

Type species.—*Ammonites nitescens* Young and Bird, 1828, p. 257 by original designation (Wiedenmayer, 1980, p. 124).

Remarks.—Ribs are coarse and strongest on the middle and upper parts of the flanks where tubercles may develop on the ventro-lateral shoulder. The occurrence of this subgenus in Europe is documented by Wiedenmayer (1980), Dommergues and Mouterde (1980), Dommergues *et al.* (1985), and Howarth (1992).

Age and distribution.—A group originating in Tethys that made early incursions into northwest Europe where endemic species evolved. The subgenus is characteristic of the Margaritatus Zone.

Protogrammoceras (Matteiceras) cf. **diornatum**
Dommergues, Meister and Fauré, 1985
Plate 23, figures 5–7; Text-figure 39i

cf. *Harpoceras volubile* (Fucini). Monestier, 1934, p. 83, pl. 1, figs. 4, 5, 20, 28.
Protogrammoceras gr. *isseli* (Fucini). Dommergues and Mouterde, 1980, pl. 1, figs. 18–20.
Protogrammoceras intermediate between *P. isseli* (Fucini) and *P. monestieri* (Fischer). Dommergues and Mouterde, 1980, pl. 3, figs. 1–3.
cf. *Protogrammoceras (Matteiceras) diornatum* Dommergues, Meister, and Fauré, 1985, p. 159, pl. 1, fig. 2; pl. 2, fig. 2; pl. 3, fig. 1.

Description.—Evolute form (U=c33) with a low expansion rate. The whorls are compressed with a low, steep umbilical wall, flat flanks and a broad venter bearing a pronounced, simple keel. The ribs are only weakly sinuous. They begin part way up the flank, are gently rursiradiate on the upper flank and weakly projected onto the venter where they fade before reaching the keel.

Type material.—Dommergues *et al.*, 1985; Holotype: pl. 2, fig. 2; paratypes: pl. 1, fig. 2, pl. 3, fig. 1.

Material.—Three incomplete specimens preserved in calcareous sandstone of the upper Fannin Formation.

Discussion.—This species differs from all other species of *Protogrammoceras* from the Queen Charlotte Islands by being the most evolute and in having its ornamentation confined to the middle and upper part of the flank.

Detailed studies of the evolution of *Protogrammoceras* based on large samples assembled by Dommergues and Mouterde (1980) and Dommergues *et al.* (1985) indicate an early appearance (Margaritatus Zone) of an eventually stout ribbed group whose ribs trend rursiradiately on the upper flank and often bear tubercles on the ventro-lateral shoulder. These species are accommodated in the subgenus *Matteiceras* (Dommergues *et al.*, 1985); included is the species *Protogrammoceras (M.) monestieri,* thought to be derived from the densely ribbed *Protogrammoceras (P.) isseli.* The three specimens from the Queen Charlotte Islands compare most favorably with forms intermediate between *P. (P.) isseli* and *P. (M.) monestieri* as illustrated by Dommergues and Mouterde (1980). These intermediate forms were subsequently included in the species *P. (Matteiceras) diornatum.* The designated holotype for this species (Dommergues *et al.*, 1985, pl. 2, fig. 2) has developed a strongly sulcate keel and fairly flexuous ribbing but at a shell diameter larger than any of the Queen Charlotte Islands specimens. Because of the discrepancy in size, a more confident species assignment will have to await the collection of larger and better preserved specimens.

Occurrence.—*Protogrammoceras (Matteiceras) diornatum* is known from the Margaritatus Zone of Switzerland, southern France, and Portugal.

Localities.—D20, FT2, I06.

Age.—Kunae Zone (Late Pliensbachian).

Genus and species indet.
Plate 23, figure 4; Text-figure 38h

Description.—A large, completely septate specimen that had a shell diameter in excess of 160 mm. The shell is evolute, expands fairly slowly and has a compressed whorl section (WWWH=c58). The umbilical wall is almost vertical, the umbilical shoulder pronounced and the flanks fairly flat. The arched venter bears a pronounced simple keel.

Ribs arise at the umbilical shoulder where, on most whorls, they merge and are weakly swollen. On the outer half whorl, the ribs fade on the lower part of the flank. Ribs are rectiradiate, gently sinuous on the flank and strongly projected onto the venter.

Material.—One internal mold from the upper Fannin Formation.

Discussion.—This specimen was not found in place but it occurred with many float Kunae Zone ammonites adjacent to in situ material; the possibility of it being derived from elsewhere in the section is considered remote. It could be a species of *Protogrammoceras* except for the fusing and swelling of ribs on the um-

Table 44.—Measurements of *Lioceratoides* (*Lioceratoides*) *allifordense* (McLearn, 1930). All measurements are in mm.

specimen no.	*DMAX*	*D*	*UD*	*U*	*WW*	*WWD*	*WH*	*WHD*	*WWWH*
GSC 9053	c76.3	c76.3	23.5	30.8	14.3	18.7	32.3	42.3	44.3
	—	24.1	—	—	c5.0	20.7	11.3	46.8	44.2
GSC 98641	45	45	11.2	24.9	c9.5	21.1	20	44.4	c47.5

bilical shoulder. More material whose stratigraphic position is unequivocal must be collected before the affinities of this form can be properly assessed.

Locality.—FT2.

Age.—Probably from the Kunae Zone.

Genus **LIOCERATOIDES** Spath, 1919

Subgenus **LIOCERATOIDES** Spath, 1919

Platyharpites Buckman, 1927, pl. 698.
Praeleioceras Fucini, 1929, p. 71.
Nagatoceras Matsumoto *in* Matsumoto and Ono, 1947, p. 28.
Neolioceratoides Cantaluppi, 1970, p. 40.

Type species.—*Leioceras? Grecoi* Fucini, 1901a, p. 91, pl. 11, figs. 4, 5, by original designation (Spath, 1919, p. 174).

Remarks.—Species of *Lioceratoides* are keeled, midvolute to involute forms with compressed whorl sections. Ribbing is falcoid or sinuous, sometimes irregular, and on early whorls shows strong primary and weaker secondary ribs; outer whorls may be smooth. See the remarks under *Pacificeras.*

Age and distribution.—*Lioceratoides* is a Tethyan genus most characteristic of the Upper Pliensbachian but it ranges into the Lower Toarcian (Guex, 1973; Wiedenmayer, 1980; Donovan *et al.*, 1981). The genus is also known in southern Japan (Hirano, 1971) and in Russia near Vladivostok (as *Protogrammoceras* cf. *serotinum, in* Sey and Kalacheva, 1980).

Lioceratoides (Lioceratoides) allifordense (McLearn, 1930)
Plate 26, figures 5, 6, 9–11; Text-figure 39a,s

Harpoceras allifordense McLearn, 1930, p. 4, pl. 2, fig. 1; McLearn, 1932, p. 65, pl. 5, figs. 1–3; Frebold, 1964b, pl. 8, fig. 5 (holotype refigured).

Description.—Midvolute form with compressed whorls bearing a pronounced, flat-topped keel. The umbilical wall is low and steep, the flanks flat, and the venter gently arched.

The innermost whorls bear coarse primary ribs and finer secondary ribs that arise by bifurcation and intercalation. At umbilical diameters greater than approximately 4 mm the complex ribbing gives way to broad flat-topped ribs that are flexuous on the flanks and strongly projected onto the venter. At umbilical diameters greater than approximately 10 mm, the ribs fade and the shell becomes smooth except for growth lines.

Type material.—Holotype: McLearn, 1932, pl. 5, figs. 1–3. Refigured herein, Pl. 26, fig. 9.

Material.—Twenty-one specimens preserved in sandstone of the upper Fannin Formation.

Measurements.—See Table 44.

Discussion.—This species is placed in *Lioceratoides (Lioceratoides)* because of its ontogenetic sequence of ornamentation change and its fairly involute, compressed shell. The ornamentation is more pronounced and the shell less involute than in *L. (L.) involutum.* In *L. (L.) maurelli,* the shell is less compressed and the ribbing more persistent. *L. (L.)* cf. *grecoi* has a less compressed whorl section, the ribs are coarser, and the division into primaries and secondaries occurs at larger shell diameters.

Occurrence.—*L. (L.) allifordense* has only been recorded from the Queen Charlotte Islands.

Localities.—DT2, D24, D26, E62, E65–68, I03.

Age.—Carlottense Zone (Late Pliensbachian) to early Toarcian.

Lioceratoides (Lioceratoides) cf. **grecoi** (Fucini, 1901a)
Plate 27, figures 1, 2

cf. *Leioceras? Grecoi* Fucini, 1901a, p. 91, pl. 11, figs. 4, 5.
cf. *Praeleioceras grecoi* Fucini. Fucini, 1931, p. 104, pl. 21, fig. 12.
(?)*Lioceratoides grecoi* (Fucini). Cantaluppi and Savi, 1968, p. 253, pl. 22, figs. 7, 8.
cf. *Lioceratoides grecoi* (Fucini). Wiedenmayer, 1980, p. 90, pl. 14, fig. 1.

Description.—Midvolute forms with an oval whorl section. The umbilical wall is low and steep, the flanks are gently rounded and the arched venter bears a pronounced, simple keel. Ribbing is irregular in strength and consists of simple flexuous ribs mixed with stout primaries that divide into two secondaries low on the flank. The primaries are prosiradiate and the secondaries rursiradiate.

Type material.—Holotype: *Leioceras? grecoi* Fucini, 1901a, pl. 11, fig. 4.

Material.—Two specimens preserved in sandstone of the upper Fannin Formation.

Discussion.—These specimens show the volution and ribbing style of *L. (L.) grecoi* but they are too small to

Table 45.—Measurements of *Lioceratoides* (*Lioceratoides*) *involutum*, new species. All measurements are in mm.

specimen no.	*DMAX*	*D*	*UD*	*U*	*WW*	*WWD*	*WH*	*WHD*	*WWWH*
GSC 98644	c58	39.5	6.8	17.2	10.1	25.6	20.0	50.6	50.5
GSC 98716	45.8	45.8	9.2	20.1	11.5	25.1	21.6	47.2	53.2
GSC 98705	22.2	22.2	4.1	18.5	—	—	11.4	51.4	—
	—	—	3.2	—	4.8	—	8	—	60.0

be identified with confidence. At shell diameters greater than the Queen Charlotte Islands material, *L. (L.) grecoi* characteristically undergoes a loss of ornamentation and a modest compression of the whorl section.

Occurrence.—*L. (L.) grecoi* is a Tethyan species recorded from the Spinatum Zone of Italy (Wiedenmayer, 1980).

Localities.—ET5, E62.

Age.—Carlottense Zone (Late Pliensbachian).

Lioceratoides (Lioceratoides) involutum,
new species
Plate 26, figures 2–4; Text-figure 39p

Description.—An involute compressed form with a steep umbilical wall that rounds abruptly into the weakly convergent, flat flanks. The venter bears a prominent, simple keel. Ornamentation is subdued and, to an umbilical diameter of approximately 8 mm, consists of forwardly inclined primaries and numerous secondaries that arise almost halfway up the flank, arch across the upper flank, and project weakly onto the venter. At larger diameters only fine growth lines are evident. A smooth aptychus valve is present in the incomplete body chamber of the holotype (Pl. 26, fig. 4c).

Type material.—Holotype: GSC 98716 (Pl. 26, fig. 4). Paratypes: GSC 98644 (Pl. 26, fig. 2), GSC 98705 (Pl. 26, fig. 3). Preserved in calcareous sandstone of the upper Fannin Formation. There are no other specimens.

Measurements.—See Table 45.

Derivation of name.—In reference to the involute shell.

Discussion.—This new species differs from all other species of *Lioceratoides (Lioceratoides)* by its involute shell and fine ornamentation. The most similar species is *Lioceratoides (L.) naumachensis* (Fucini, 1929) from the uppermost Pliensbachian (Emaciatum Zone) of Spain and elsewhere in southern Europe (Braga, 1983).

Table 46.—Measurements of *Lioceratoides* (*Lioceratoides*) *maurelli* (McLearn, 1930). All measurements are in mm.

specimen no.	*DMAX*	*UD*	*WW*	*WH*	*WWWH*
GSC 9052	c72	19.2	c19	33	c57.6

The European species differs by being less involute, more compressed and with ribbing persisting to larger shell diameters.

Occurrence.—This species has only been collected from the Upper Pliensbachian of the Queen Charlotte Islands.

Localities.—ET5, E62.

Age.—Carlottense Zone (Late Pliensbachian).

Lioceratoides (Lioceratoides) maurelli
(McLearn, 1930)
Plate 26, figure 1

Harpoceras maurelli McLearn, 1930, p. 4, pl. 1; 1932, p. 63, pl. 7, figs. 4–6.

Description.—A midvolute species with a compressed whorl section bearing a pronounced keel. On the innermost whorls there are broadly spaced primary ribs dividing into two secondary ribs. On later whorls the ribs are sinuous and strongly projected onto the venter. Ribbing becomes more flat-topped and weaker with growth.

Type material.—A single incomplete, septate specimen, the holotype (GSC 9502), preserved in sandstone of the upper Fannin Formation.

Measurements.—See Table 46.

Discussion.—This species was established by McLearn (1930, 1932) based on a single specimen and unfortunately no more specimens have been collected since. We place the species in *Lioceratoides* because of the style and ontogenetic changes seen in the ribbing, although the coiling is a little more evolute and the whorl section somewhat less compressed than is normally the case for this genus.

Occurrence.—This specimen was collected by McLearn from a stratigraphic interval that spans the Pliensbachian-Toarcian boundary as discussed in the biostratigraphy section (Text-fig. 10); its precise age is uncertain.

Locality.—DT2.

Age.—Carlottense Zone (Late Pliensbachian) or Early Toarcian.

Lioceratoides (Lioceratoides) sp. juv.
Plate 26, figures 7, 8; Text-figure 39r

Harpoceras sp. A. McLearn, 1932, p. 66, pl. 7, figs. 1, 2.

Table 47.—Measurements of *Lioceratoides* (*Lioceratoides*) sp. juv. All measurements are in mm.

specimen no.	*DMAX*	*D*	*UD*	*U*	*WW*	*WWD*	*WH*	*WHD*	*WWWH*	*PRHW*
GSC 98642	27.5	22.7	6	26.4	5.5	24.2	9.5	41.9	57.9	20
GSC 6489	29.6	25	6.8	27.2	6.0	24.0	c10.3	41.2	58.3	c20

Description.—Midvolute, rapidly expanding form with an ogival whorl section. The umbilical wall is low and very steep; the flanks are flat; and the arched venter bears a prominent, simple keel. The nucleus has blunt, widely spaced primaries bearing two rursiradiate secondaries. At umbilical diameters of 5 mm or so, the ribbing becomes simple, densely spaced, falcoid and flat-topped.

Material.—Four small specimens in sandstone of the upper Fannin Formation.

Measurements.—See Table 47.

Discussion.—This form was first figured by McLearn (1932) based on a single specimen collected in Whiteaves Bay (section D) that McLearn interpreted as an immature *Harpoceras*; the specimen is refigured here (Plate 26, figure 7). The presence of primary and secondary ribs at an early ontogenetic stage together with its now proven geological age (preceding *Harpoceras*) suggest that *Lioceratoides* is a more appropriate generic assignment. Because of its small size, it cannot be confidently identified to the species level; it does not appear to be similar to the nuclei of any of the other species of *Lioceratoides (L.)* described in this report.

Occurrence.—Similar but not identical ammonites have been collected from the Upper Pliensbachian of Oregon and California and figured as *Harpoceras?* sp. by Imlay (1968).

Localities.—DT2, D26, ET5, E67.

Age.—Carlottense Zone (Late Pliensbachian) to early Toarcian.

Subgenus **PACIFICERAS** Repin, 1970

Type species.—*Schloenbachia propinqua* Whiteaves, 1884, p. 274, pl. 33, fig. 2, by original designation (Repin, 1970, p. 42).

Remarks.—Repin (1970) originally established *Pacificeras* as a subgenus of *Ovaticeras* to accommodate Toarcian forms from Russia that have been placed in *Tiltoniceras antiquum* (Wright, 1882) by Howarth (1992). *Schloenbachia propinqua* Whiteaves, 1884, from the Queen Charlotte Islands (on which *Pacificeras* is based) has been reevaluated here because it appears to have a bearing on the evolutionary relationships between the genera *Lioceratoides, Tiltoniceras,* and *Protogrammoceras. Pacificeras, Lioceratoides* and *Tiltoniceras* accommodate forms that are all characterized by a strong simple keel but otherwise represent a morphological spectrum with *Pacificeras* occupying the middle ground.

Lioceratoides consists of midvolute to involute, rapidly expanding forms with compressed whorls. The ornamentation passes through as many as three stages during ontogeny: (1) irregular primary ribs with bifurcating or bundled secondaries on the inner whorls; (2) simple, falcoid, projected and often flattened ribs on intermediate or outer whorls; (3) on some forms the falcoid stage is brief or absent and the shell becomes smooth.

Forms accommodated in *Pacificeras* are less involute and less compressed than forms assigned to *Lioceratoides.* The inner whorls have ribs divided into short primaries and weaker secondaries. At smaller shell diameters than in *Lioceratoides* the ornamentation simplifies into weak, single ribs and the shell rapidly becomes smooth.

Like *Pacificeras, Tiltoniceras* is less involute and less compressed than *Lioceratoides* but ribs are never divided into primaries and secondaries. Simple, flexuous, projected ribs characterize the inner whorls whereas outer whorls are smooth or striate.

Age and distribution.—In North America, *Pacificeras, Lioceratoides,* and *Tiltoniceras* have similar stratigraphic distributions. In the lower part of their ranges, they co-occur with species of *Fanninoceras* and *Amaltheus* (Smith *et al.,* 1988; Thomson and Smith, 1992) indicating a late Pliensbachian age and representing the earliest records for *Tiltoniceras* and *Pacificeras.* In the upper part of their ranges above *Fanninoceras* and *Amaltheus,* they co-occur with species of *Dactylioceras* indicating an early Toarcian age (Smith *et al.,* 1988; Tipper *et al.,* 1991; Jakobs *et al.,* 1994b). Elsewhere, *Lioceratoides* occurs throughout the Tethyan Realm where it is most characteristic of the late Pliensbachian although the last representatives occur in the basal Toarcian (Guex, 1973; Wiedenmayer, 1980). In contrast, *Tiltoniceras* is restricted to higher latitudes where it appears cryptically in the basal Toarcian of Russia and northwest Europe (Howarth, 1992). We suggest that *Tiltoniceras* evolved in the northeast Pacific during the late Pliensbachian, not directly from *Protogrammoceras,* but indirectly via *Lioceratoides* and *Pacificeras.*

Table 48.—Measurements of *Lioceratoides* (*Pacificeras*) *angionus* (Fucini, 1931). All measurements are in mm.

specimen no.	*DMAX*	*D*	*UD*	*U*	*WW*	*WWD*	*WH*	*WHD*	*WWWH*
GSC 98611	c53	47	11.5	24.5	—	—	20.5	43.6	—
GSC 99045	c98	76.2	26.7	35.0	19.4	25.5	27.2	35.7	71.3
	—	—	12	—	11.3	—	19	—	59.5
GSC 98634	c56	45	12.5	27.8	11.8	26.2	c19	42.2	62.1
GSC 98640	47	43	12.0	27.9	10.3	24.0	17.0	39.5	60.1
GSC 98732	82	65.2	16.5	25.3	15.8	24.2	27.9	42.8	56.6
MEAN	—	—	—	28.1	—	25.0	—	40.8	61.9
ST. DEV.	—	—	—	4.1	—	1.1	—	3.2	5.6

Lioceratoides (Pacificeras) angionus
(Fucini, 1931)
Plate 27, figures 3–7; Text-figure 39k,o

Praelioceras angionum Fucini, 1931, p. 107, pl. 12, figs. 1–5.
Lioceratoides angionus (Fucini). Guex, 1973, p. 507, pl. 1, fig. 5.

Description.—A midvolute to evolute form characterized by its compressed whorl section that becomes subquadrate with growth. The umbilical wall is steep and rounds abruptly into the flat flanks which are weakly convergent towards the venter until umbilical diameters of approximately 10 mm after which they are almost parallel.

The broad, flat venter bears a prominent, stout keel. Ornamentation is weak consisting of prorsiradiate primaries that divide irregularly into two or three weaker secondary ribs that arch across the upper flank but fade near the ventro-lateral shoulder. On the smaller figured specimens the ribbing has faded to simple growth lines but on the two larger specimens (Pl. 27, figures 4 and 7) ribbing persists to larger shell diameters. Specimen 98732 (Pl. 27, figure 7) is completely septate but specimen 99045 (Pl. 27, figure 4) has part of a body chamber that is beginning to egress.

Type material.—Lectotype: Fucini, 1931, pl. 12, fig. 1.

Material.—Nine specimens in calcareous sandstone of the upper Fannin Formation.

Measurements.—See Table 48.

Discussion.—This species differs from *L. (P.) propinquum* in its whorl shape, notably the steep umbilical wall, parallel flanks and tabulate venter.

There are no firm criteria amongst the collection for judging maturity but it is postulated that the larger figured specimens represent incomplete macroconchs. This question can only be resolved when appropriately well preserved material is collected.

The specimens of *L. (P.) angionus* that have been illustrated in the literature (see synonymy) are all small (up to 40 mm or so shell diameter) so that comparisons with the Queen Charlotte Islands fauna are difficult. The smaller Canadian specimens (Pl. 27, figures 3, 5, 6), with their irregular ribbing quickly declining to growth lines and their steep umbilical wall, compare reasonably well, however.

Occurrence.—*L. (P.) angionus* is known from the Upper Pliensbachian of Italy (Fucini, 1931) and the lowest Toarcian of Morocco (Guex, 1973).

Localities.—D24, ET5, E65, E67, E68.

Age.—Carlottense Zone (Late Pliensbachian).

Lioceratoides (Pacificeras) propinquum
(Whiteaves, 1884)
Plate 28, figures 1–11; Plate 29, figure 1;
Text-figures 38d-g, 39n,q

Schloenbachia propinqua Whiteaves, 1884, p. 247; 1900, pl. 33, figs. 2 and 2a.
Harpoceras propinquum (Whiteaves). McLearn, 1930, p. 4; 1932, p. 66, pl. 6, figs. 1–4; pl. 7, fig. 3; Shimer and Schrock, 1944, pl. 240, figs. 13, 14; Frebold, 1964b, pl. 8, figs. 4, 6, 7.
(?) *Harpoceras* sp. juvenile. Frebold, 1964a, p. 16, pl. 6, figs. 6, 7 only.
non *Ovaticeras propinquum* (Whiteaves). Repin, 1968, p. 116, pl. 44, fig. 1; pl. 45, fig. 1.
non *Tiltoniceras propinquum* (Whiteaves). Dagis, 1971, p. 75, pl. 4, figs. 4, 5; 1974, p. 21, pl. 1, figs. 1–4; pl. 2, fig. 1.
Tiltoniceras propinquum (Whiteaves). Smith, Tipper, Taylor, and Guex, 1988, pl. 5, figs. 1–4; Thomson and Smith, 1992, p. 39, pl. 15, figs. 5–7 only.
Lioceratoides n. sp. Smith, Tipper, Taylor, and Guex, 1988, pl. 5, figs. 7, 8.

Description.—Large, evolute and fairly slowly expanding with a compressed whorl section. The umbilical wall rounds gently into the convex flanks and the arched venter bears a prominent, simple keel. There is considerable variation in the strength of the ribbing within the sample. The early whorls show widely spaced primary ribs developed by fasciculation or bifurcation of secondaries fairly low on the flank. A few intercalated ribs are also present. By umbilical diameters of 7 mm the ribs have become simple, densely spaced and flexuous. They quickly fade, leaving most of the shell smooth except for growth lines.

Type material.—Lectotype: GSC 4877 (Whiteaves, 1900, pl. 33, figs. 2, 2a (refigured herein, Pl. 28, fig. 2).

Table 49.—Measurements of *Lioceratoides* (*Pacificeras*) *propinquum* (Whiteaves, 1884). All measurements are in mm.

specimen no.	*DMAX*	*D*	*UD*	*U*	*WW*	*WWD*	*WH*	*WHD*	*WWWH*
GSC 4877	47.6	47.6	16.5	34.7	10.5	22.1	19.2	40.3	54.7
GSC 6490	182	137	62.7	36.2	c33.4	19.3	66.2	38.3	c50.5
		155	57.5	37.1	33.7	21.7	59.7	38.5	56.5
GSC 6491	37.5	32.7	10.0	30.6	8.2	25.1	13.6	41.6	60.3
GSC 87804	63.6	59.0	23.0	39.0	14.6	24.7	23.5	39.8	62.1
GSC 87806	32.2	32.2	9.2	28.6	7.4	23.0	13.5	41.9	54.8
GSC 98655	38.3	30.5	9.2	30.2	7.6	24.9	13.1	43.0	57.6
GSC 98661	38.0	35.6	9.7	27.2	—	—	15.5	43.5	
GSC 98676	20.0	20.0	5.4	27.0	5.5	27.5	9.1	45.5	60.4
GSC 98681	26.9	26.9	7.8	29.0	6.1	22.7	11.3	42.0	54.0
GSC 98682	c28.0	23.0	7.0	30.4	—	—	10.0	43.5	—
GSC 98685	31.3	25.5	8.9	34.9	6.2	24.3	10.2	40.0	60.8
GSC 98687	64.2	56.2	19.4	25.4	13.3	23.7	20.2	35.9	65.8
MEAN	—	—	—	31.6	—	23.5	—	41.1	58.0
ST. DEV.	—	—	—	4.3	—	2.2	—	2.6	4.4

When McLearn designated the lectotype (1932, p. 67) he also recognized two plesiotypes (McLearn, 1932, pl. 6, figs. 1 and 2 and pl. 7, fig. 3). The plesiotypes are refigured herein (GSC 6491, Pl. 28, fig. 7; GSC 6490, Pl. 29, fig. 1).

Material.—143 specimens in sandstone and siltstone of the Fannin Formation.

Measurements.—See Table 49.

Discussion.—When Whiteaves first described this species he indicated that the best preserved figured specimen, which later became the lectotype (McLearn, 1932), originated from South Bay which is now known as Whiteaves Bay (section D herein. p. 14). Unfortunately, the publication of the plate was unexpectedly delayed until part 4 of Whiteaves' work on fossils from the Queen Charlotte Islands (Whiteaves, 1900) in which the fossil was reported to have come from Maude Island (section E herein, p. 15) and this has led to confusion in subsequent literature. From the context of Whiteaves' original description and in agreement with McLearn's conclusion (McLearn, 1932, p. 69), we believe that the specimen did, in fact, originate from Whiteaves Bay.

This large species had been previously reported from North America and Russia but Howarth (1992) has re-evaluated these reports and concludes that the Russian material, with its simpler ribbing, was better accommodated in the species *Tiltoniceras antiquum* (described below). The North American specimens are distinguished by early whorls that have complex ribs followed by simple ribs and then smooth shells, a pattern more akin to *Lioceratoides*. As discussed above, *Pacificeras* with its more evolute and slowly expanding shell, is retained as a subgenus of *Lioceratoides* based on *Schloenbachia propinqua* of Whiteaves (1884) as type (Repin, 1970).

Occurrence.—As interpreted here, *L. (P.) propinquum* is only known from the northeast Pacific.

Localities.—DT2, D24–27, ET5, E62–68, IO3, I12.

Age.—Carlottense Zone (Late Pliensbachian) to early Toarcian.

Genus **TILTONICERAS** Buckman, 1913

Type species.—*Tiltoniceras costatum* Buckman, 1913, p. 8, by original designation. *T. costatum* is a subjective junior synonym of *Harpoceras antiquum* Wright, 1882 (Howarth, 1973, 1992).

Remarks.—See the remarks under *Pacificeras.* The genus has been recently discussed in detail by Howarth (1992) who considers it monospecific.

Age and distribution.—*T. antiquum* first occurs in the upper Pliensbachian of western North America becoming widespread in Boreal, lower Toarcian rocks of northeast Siberia, Germany, and Great Britain.

Tiltoniceras antiquum (Wright, 1882)
Plate 30, figures 1–4; Text-figure 39l-m

Harpoceras antiquum Wright, 1882, pl. 57, figs. 1, 2.
Harpoceras acutum (Tate). Wright, 1884, p. 469, pl. 82, figs. 7, 8.
Ammonites capillatus Denckmann, 1887, p. 60, pl. 1, fig. 7; pl. 4, fig. 3.
Harpoceras schroederi Denckmann, 1893, p. 101.
Tiltoniceras costatum Buckman, 1913, p. viii; 1914, pl. 97, figs. 1–4; Hoffmann, 1968, p. 15, pl. 4, fig. 3; Dagis, 1974, p. 23, pl. 3, figs. 1–4.
Tiltoniceras acutum Tate. Donovan, 1954, p. 51; Hoffman, 1968, p. 13, pl. 3, fig. 4; Lehmann, 1968, p. 56, pl. 19, fig. 6.
Harpoceras sp. juv. Frebold, 1964a, p. 16, pl. 6, figs. 8, 9 only.
Tiltoniceras schroederi (Denckmann). Hoffmann and Martin, 1960, p. 116, pl. 9, figs. 6, 7, 12; Hoffmann, 1968, p. 13, pl. 4, fig. 2.
Ovaticeras facetum Repin, 1966, p. 45, pl. 1, figs. 4, 5, 8; 1968, p. 115, pl. 46, figs. 1, 2, 4, 5.
Tiltoniceras capillatum (Denckmann). Hoffmann, 1968, p. 17, pl. 5, figs. 1–4; Lehmann, 1968, p. 57, pl. 20, figs. 1, 2, 8; Dagis, 1974, p. 25, pl. 3, figs. 5, 6.

Table 50.—Measurements of *Tiltoniceras antiquum* (Wright, 1882). All measurements are in mm.

specimen no.	*DMAX*	*D*	*UD*	*U*	*WW*	*WWD*	*WH*	*WHD*	*WWWH*
GSC 98713	39.0	32.0	7.9	24.7	7.8	24.4	15.6	48.8	50
GSC 98728	c158	150.8	41.0	27.2	35.4	23.4	65.7	43.5	53.9
GSC 98730	—	45.7	11.8	25.8	11.1	24.3	21.8	47.7	50.9
GSC 98731	59.5	59.5	17.5	29.4	—	—	23.6	39.7	—
		48.0	12.0	25.0	11.7	24.4	20.5	42.7	42.7
MEAN	—	—	—	26.4	—	24.1	—	44.5	49.4
ST. DEV.	—	—	—	1.9	—	0.5	—	3.7	4.8

Ovaticeras propinquum (Whiteaves). Repin, 1968, p. 116, pl. 44, fig. 1; pl. 45, fig. 1.
Tiltoniceras propinquum (Whiteaves). Dagis, 1971, p. 175, pl. 4, figs. 4, 5; 1974, p. 21, pl. 1, figs. 1–4; pl. 2, fig. 1; Thomson and Smith, 1992, p. 39, pl. 15, figs. 4, 8 and 9 only.
Tiltoniceras antiquum (Wright). Schlegelmilch, 1976, p. 88, pl. 46, figs. 5, 6; Howarth, 1992, p. 70, Text-figures 13, 18; pl. 5, fig. 3; pl. 6, figs. 1–8; pl. 7, figs. 1–3, 9.
(?)*Ovaticeras* sp. cf. *O. ovatum* (Young and Bird). Poulton, 1991, p. 20, pl. 13, figs. 7, 11.
(?)*Harpoceras?* sp. Poulton, 1991, p. 20, pl. 13, fig. 8 only.

Description.—Midvolute, large and thick-shelled form with compressed whorls bearing a prominent, simple keel. The umbilical wall is gently sloped, the umbilical shoulder indistinct and the flanks gently convex.

Ribs are fine and simple. They are prorsiradiate and sinuous across the flank and projected ventrally. Ribbing fades at umbilical diameters of 8 mm or so to be replaced by a smooth or striate shell.

Type material.—Lectotype: Wright, 1882, pl. 57, figs. 1 and 2 designated by Donovan (1954, p. 44) and refigured by Howarth (1992, Text-fig. 13).

Material.—Seventy-five specimens from the upper Fannin Formation.

Measurements.—See Table 50.

Discussion.—This species reaches a large size as exemplifed by the specimen figured on Plate 30, figure 1 which has a diameter of almost 160 mm and yet is still septate. Three other similarly large and completely septate specimens also occur in the collection but most are incomplete and less than 50 mm in shell diameter. An exception, indicating the presence of dimorphism, is figured on Plate 30, figure 4. This specimen has a diameter of almost 60 mm and a body chamber just under half a whorl in length. The body chamber, which egresses slightly, has a peristome that is sinuous, in harmony with the now obsolete ribbing; it flares in the central part of the flank end projects ventrally to form a rostrum. One other, unfigured specimen reaches a diameter of over 78 mm and has a body chamber length of about half a whorl. The peristome is mostly incomplete but where it remains it shows a similar flaring.

T. antiquum differs from *Lioceratoides (Pacificeras) propinquum* in being slightly more involute and more rapidly expanding and in having ribs that are never divided into primaries and secondaries. *L. (P.) angionus* also has more complex ribbing on its earlier whorl and is further characterized by its steep umbilical wall and more pronounced umbilical shoulder.

Occurrence.—As discussed in the introduction to *Pacificeras* (p. 70), *T. antiquum* is characteristic of the Boreal Realm where it normally occurs in the basal Toarcian. In the Queen Charlotte Islands and elsewhere in Canada it also occurs in the uppermost Pliensbachian and presumably it had its origin within *Lioceratoides.*

Localities.—B06, DT2, D27, ET5, E62–68.

Age.—Carlottense Zone (Late Pliensbachian) and early Toarcian.

APPENDIX

LOCALITY REGISTER

A brief geographical description, latitude, longitude, and 1:50,000 map sheet are given for stratigraphic sections and locality numbers cited in the text; type numbers are also listed by locality. Refer to Text-figures 2 and 3 for locations.

SECTION A: KUNGA ISLAND (Text-figures 2, 7 and 16)

Localities A01 to A13 in a stratigraphic sequence exposed along the southeast shore of Kunga Island, 52°45′53″N, 131°33′08″W; NTS 103B/13 & 14, Louise Island.

A01 UBC loc. PLS-14, Sandilands Formation
A02 UBC loc. PLS-13, Ghost Creek Formation
A03 UBC loc. PLS-12, Ghost Creek Formation
A04 UBC loc. PLS-11, Ghost Creek Formation
A05 UBC loc. PLS-10, Ghost Creek Formation
A06 UBC loc. PLS-9, Ghost Creek Formation
A07 UBC loc. PLS-8, Ghost Creek Formation
A08 UBC loc. PLS-7, Ghost Creek Formation
A09 UBC loc. PLS-6, Rennell Junction Member (of the Fannin Formation)
A10 UBC loc. PLS-5, Rennell Junction Member
A11 UBC loc. PLS-4, Rennell Junction Member

A12 UBC loc. PLS-2, Rennell Junction Member
A13 UBC loc. PLS-1, Rennell Junction Member

SECTION B: LOUISE ISLAND (Text-figures 2, 8 and 17)

Localities BT1 (talus), and B01 to B06 in a stratigraphic sequence exposed on the north shore of Louise Island at Renner Point, between 53°02′03″N, 131°52′48″W and 53°02′06″N, 131°52′47″W; NTS 103G/4, Cumshewa.

BT1 GSC loc. C-117025, GSC type 98702, Ghost Creek Formation
B01 GSC loc. C-117022, Ghost Creek Formation
B02 GSC loc. C-117021, Ghost Creek Formation
B03 GSC loc. C-117020, Rennell Junction Member
B04 GSC loc. C-117019, GSC types 95575, 98626, 98627, 98628, 98629, 98630, 98633, 98636, 98637, 98639, Rennell Junction Member
B05 GSC loc. C-117018, Fannin Formation
B06 GSC loc. C-117017, Fannin Formation

SECTION C: CUMSHEWA INLET (Text-figures 2, 9 and 18)

Localities CT1, CT2 (talus), and C01 to C05 in a stratigraphic sequence exposed on the north shore of Cumshewa Inlet, 53°02′53″N, 131°56′05″W; NTS 103G/4, Cumshewa.

CT1 GSC loc. C-157644, Ghost Creek Formation
GSC loc. C-157645, Ghost Creek Formation
CT2 GSC loc. C-157607, Ghost Creek Formation
GSC loc. C-157647, Ghost Creek Formation
GSC loc. C-157648, Ghost Creek Formation
C01 GSC loc. C-157609, Ghost Creek Formation
GSC loc. C-157650, Ghost Creek Formation
C02 GSC loc. C-117026, Rennell Junction Member
GSC loc. C-157671, Rennell Junction Member
C03 GSC loc. C-80610, GSC type 87797, Fannin Formation
GSC loc. C-117027, GSC type 98692, Fannin Formation
GSC loc. C-157668, Fannin Formation
GSC loc. C-157670, Fannin Formation
C04 GSC loc. C-157612, Fannin Formation
C05 GSC loc. C-157649, Fannin Formation

SECTION D: WHITEAVES BAY (Text-figures 2, 10 and 19)

Localities DT1, DT2 (talus), and D01 to D28 in a stratigraphic sequence exposed in Whiteaves Bay on the north shore of Moresby Island, 53°11′N, 132°01′W; NTS 103F/1, Skidegate Inlet.

DT1 GSC loc. O-48564, GSC types 87800, 98673, 98674, 98675, 99020, Fannin Formation
DT2 GSC loc. O-13630, GSC type 9052, 99046, Fannin Formation
GSC loc. C-117033, GSC types 4877, 6489, 6490, 6491, 9053, Fannin Formation
D01 GSC loc. O-93568, Ghost Creek Formation
D02 GSC loc. C-80242, Ghost Creek Formation
D03 GSC loc. O-93565, GSC types 98688, 98691, Ghost Creek Formation
GSC loc. C-80243, Ghost Creek Formation
D04 GSC loc. C-80244, Ghost Creek Formation
D05 GSC loc. C-80245, Ghost Creek Formation
D06 GSC loc. C-80246, GSC type 98656, Ghost Creek Formation
GSC loc. C-80247, Ghost Creek Formation
D07 GSC loc. C-80248, Ghost Creek Formation
GSC loc. C-80249, GSC types 98695, 98707, Ghost Creek Formation
GSC loc. C-80250, Ghost Creek Formation
GSC loc. C-80751, Ghost Creek Formation
GSC loc. C-80752, Ghost Creek Formation
D08 GSC loc. O-93564, GSC types 98654, 98693, 99044, Ghost Creek Formation
GSC loc. C-80753, Ghost Creek Formation
D09 GSC loc. O-93571, Ghost Creek Formation
D10 GSC loc. C-80754, Ghost Creek Formation
D11 GSC loc. O-93575, GSC type 95573, Ghost Creek Formation
GSC loc. C-80755, GSC type 98645, Ghost Creek Formation
D12 GSC loc. C-80756, Ghost Creek Formation
D13 GSC loc. C-80757, Ghost Creek Formation
D14 GSC loc. C-80758, Rennell Junction Member
D15 GSC loc. C-80759, Rennell Junction Member
D16 GSC loc. C-80760, Rennell Junction Member
D17 GSC loc. C-80761, Rennell Junction Member
D18 GSC loc. O-93563, Rennell Junction Member
D19 GSC loc. C-80764, Fannin Formation
D20 GSC loc. C-80765, GSC types 99018, 98590, 98619, 98620, 98742, Fannin Formation
D21 GSC locs. C-80766, Fannin Formation
D22 GSC loc. C-80768, GSC type 98584, Fannin Formation
D23 GSC loc. C-80769, Fannin Formation
D24 GSC loc. O-93574, GSC types 98643, 98732, 98733, 98739, Fannin Formation
GSC loc. C-80771, Fannin Formation
D25 GSC loc. C-80772, GSC type 98740, Fannin Formation
D26 GSC loc. O-93582, GSC type 98642, Fannin Formation
GSC loc. C-80773, Fannin Formation
D27 GSC loc. C-80774, Fannin Formation
GSC loc. C-80776, GSC type 98746, Fannin Formation
D28 GSC loc. C-80775, Fannin Formation

SECTION E: MAUDE ISLAND (Text-figures 2, 11 and 20)

Localities ET1 to ET5 (talus), and E01 to E79 in a stratigraphic sequence exposed in Fannin Bay on the southeast side of Maude Island, 53°12′N, 132°03′W; NTS 103F/1, Skidegate Inlet.

ET1 GSC loc. O-48603, GSC types 20337, 87810, 98631, 98632, 98689
GSC loc. O-93577, GSC type 98667
GSC loc. O-93743, GSC type 98575
GSC loc. O-93748
GSC loc. C-80836, GSC types 87811, 98657, Fannin Formation
ET2 GSC locs. O-52342, O-93744, Rennell Junction Member
ET3 GSC locs. C-80835, C-80837, C-80838, Rennell Junction Member
GSC loc. C-80840, GSC types 98625, 98696, Rennell Junction Member
GSC locs. C-80841, C-80844, C-80845, C-81916, C-118698, Rennell Junction Member
ET4 GSC loc. O-13628, GSC types 98576, 98577, 98579, 98594, Fannin Formation
GSC loc. O-48573, GSC types 87798, 98578, Fannin Formation
GSC loc. O-93579, GSC type 98709, Fannin Formation
GSC loc. O-93741, GSC type 98581, 98622, Fannin Formation
GSC loc. C-80839, GSC types 98597, 98610, Fannin Formation
GSC loc. C-81724, GSC type 98608, Fannin Formation
GSC loc. C-117032, GSC types 6493, 6494, 6495, 6496, 6517, 6518, 9054, 9058, 98684, Fannin Formation
GSC loc. C-117034, GSC types 4876, 4879, 6519, 6670, 9055, Fannin Formation
ET5 GSC loc. O-48563, GSC type 98716, Fannin Formation

GSC loc. O-93578, Fannin Formation
GSC loc. C-80814, GSC type 98598, Fannin Formation
GSC loc. C-80824, GSC type 98685, Fannin Formation
GSC loc. C-80831, GSC type 98586, Fannin Formation
GSC loc. C-80832, GSC type 98694, Fannin Formation
GSC loc. C-80833, GSC type 99040, Fannin Formation
GSC loc. C-80834, GSC types 98585, 98744, Fannin Formation
GSC loc. C-81917, GSC type 98644, Fannin Formation
GSC loc. C-117002, GSC types 98677, 98718, 98730, Fannin Formation. Ammonites found together in a single boulder.
GSC loc. C-117003, GSC types 87804, 87806, 87809, 98676, 98697, 99045, Fannin Formation. Ammonites found together in a single boulder.
GSC loc. C-117004, Fannin Formation. Ammonites found together in a single boulder.
GSC loc. C-117005, 98589, 98731, 99015, Fannin Formation. Ammonites found together in a single boulder.
GSC loc. C-117030, Fannin Formation
GSC loc. C-117031, GSC types 4878, 87807, 98728, 98734, 98735, Fannin Formation
UBC loc. 82–14, Fannin Formation
E01 GSC loc. C-80241, GSC type 98650, Ghost Creek Formation
GSC locs. O-91819, C-80315, Ghost Creek Formation
E02 GSC loc. C-80318, Ghost Creek Formation
E03 GSC loc. C-80319, Ghost Creek Formation
E04 GSC locs. C-80321, C-80323, Ghost Creek Formation
E05 GSC loc. C-80324, Ghost Creek Formation
E06 GSC loc. O-91820, Ghost Creek Formation
E07 GSC locs. O-91821, C-80325, Ghost Creek Formation
E08 GSC locs. O-91822, C-80326, Ghost Creek Formation
E09 GSC loc. O-91823, Ghost Creek Formation
E10 GSC loc. C-80328, Ghost Creek Formation
E11 GSC loc. O-91824, Ghost Creek Formation
E12 GSC loc. O-91825, Ghost Creek Formation
E13 GSC loc. O-91805, Ghost Creek Formation
GSC loc. C-80329, GSC type 98660, Ghost Creek Formation
E14 GSC loc. O-91799, Ghost Creek Formation
GSC loc. C-80330, GSC type 98665, Ghost Creek Formation
E15 GSC loc. O-91796, Ghost Creek Formation
E16 GSC loc. C-80331, Ghost Creek Formation
E17 GSC loc. C-80332, Rennell Junction Member
E18 GSC loc. O-91797, Rennell Junction Member
E19 GSC loc. C-80333, Rennell Junction Member
E20 GSC loc. O-91803, GSC type 98664, Rennell Junction Member
E21 GSC loc. C-80334, Rennell Junction Member
E22 GSC loc. O-91802, Rennell Junction Member
E23 GSC locs. O-91801, C-80336, Rennell Junction Member
E24 GSC loc. O-91798, Rennell Junction Member
E25 GSC locs. O-91793, C-80337, Rennell Junction Member
E26 GSC loc. O-91795, Rennell Junction Member
E27 GSC loc. O-91794, GSC types 87790, 87791, 95576, 98653, Rennell Junction Member
GSC loc. C-80338, Rennell Junction Member
E28 GSC loc. C-80340, Rennell Junction Member
E29 GSC loc. C-80341, Rennell Junction Member
E30 GSC locs. C-80342, C-80343, C-90555, Rennell Junction Member
E31 GSC loc. C-80344, Rennell Junction Member
E32 GSC loc. O-91807, GSC type 78715, Rennell Junction Member
E33 GSC loc. O-91811, Rennell Junction Member
E34 GSC locs. O-91815, C-80345, Rennell Junction Member
GSC loc. O-91814, GSC type 98648, Rennell Junction Member
E35 GSC loc. O-91810, Rennell Junction Member
E36 GSC loc. C-80346, Rennell Junction Member
E37 GSC loc. C-80347, Rennell Junction Member
E38 GSC loc. C-80348, GSC type 98703, Rennell Junction Member
E39 GSC loc. C-80349, Rennell Junction Member
E40 GSC loc. C-80350, GSC type 98669, Rennell Junction Member
E41 GSC loc. C-80215, Rennell Junction Member
E42 GSC loc. C-80216, Rennell Junction Member
E43 GSC loc. C-80217, Rennell Junction Member
E44 GSC loc. O-91818, Rennell Junction Member
E45 GSC locs. C-80219, C-80220, Rennell Junction Member
E46 GSC loc. C-80221, Rennell Junction Member
E47 GSC loc. C-80222, Rennell Junction Member
E48 GSC loc. C-90554, GSC type 98686, Rennell Junction Member
E49 GSC loc. C-80223, Rennell Junction Member
E50 GSC loc. C-80224, Fannin Formation
E51 GSC loc. C-80226, Fannin Formation
GSC loc. C-117284, GSC type 98670, Fannin Formation
E52 GSC loc. C-90553, GSC types 87801, 98583, Fannin Formation
E53 GSC loc. C-80228, GSC type 98701, Fannin Formation
E54 GSC loc. C-80229, Fannin Formation
E55 GSC loc. O-91827, GSC types 98574, 98607, Fannin Formation
GSC locs. C-80231, C-80232, Fannin Formation
E56 GSC loc. O-91828, Fannin Formation
GSC loc. C-80233, GSC type 98623, Fannin Formation
E57 GSC loc. C-80234, GSC types 98614, 98615, 98616, 98617, 98624, Fannin Formation
GSC loc. C-90614, GSC types 87796, 98672, 98706, 98708, Fannin Formation
E58 GSC loc. C-80235, Fannin Formation
E59 GSC loc. O-91830, Fannin Formation
E60 GSC loc. C-80240, Fannin Formation
E61 GSC loc. C-80825, GSC type 98698, Fannin Formation
E62 GSC loc. O-91792, Fannin Formation
GSC loc. C-81716, GSC types 87805, 98679, 98687, 98705, 98729, 99016, Fannin Formation
E63 GSC loc. O-91816, Fannin Formation
GSC loc. O-93750, GSC types 98588, 98600, 98727, 98745, Fannin Formation
GSC loc. C-90545, GSC types 98613, 98649, 98681, 98682, 98741, 99017, Fannin Formation
E64 GSC loc. O-91832, GSC type 99046, Fannin Formation
GSC loc. O-91833, Fannin Formation
E65 GSC loc. O-91834, Fannin Formation
GSC loc. O-91835, GSC types 98640, 98736, Fannin Formation
GSC loc. C-80783, GSC type 98611, Fannin Formation
GSC loc. C-90544, GSC type 98713, Fannin Formation
E66 GSC locs. C-80784, C-80818, Fannin Formation
GSC loc. C-80817, GSC type 98690, Fannin Formation
E67 GSC loc. C-80785, GSC types 98634, 98641, 98655, 98661, Fannin Formation
GSC loc. C-80815, Fannin Formation
E68 GSC loc. C-80786, GSC type 87808, Fannin Formation
GSC loc. C-90615, Fannin Formation

SECTION F: ROAD 19 QUARRY (Text-figures 3, 12 and 21)

Localities FT1 and FT2 (talus), and F01 to F12 in a stratigraphic sequence measured in a quarry on the north side of Forest Road 19 at 53°22′30″, 132°16′00″; NTS 103F/8, Yakoun River.

FT1 GSC loc. C-156675, GSC types 98710, 98738, 99027, 99038, 99041, 99042, 99043, Rennell Junction Member

GSC loc. C-177370, GSC types 87809, 98651, 98671, 99022, 99023, 99024, 99039, Rennell Junction Member
FT2 GSC loc. C-56954, GSC types 98711, 99013, 99014, Fannin Formation
GSC loc. C-177368, types 98592, 99032, 99033, 99034, 99035, 99036, 99037, Fannin Formation
F01 GSC loc. C-177371, Rennell Junction Member
F02 GSC loc. C-177369, Rennell Junction Member
F03 GSC loc. C-177358, Rennell Junction Member
F04 GSC loc. C-177359, Rennell Junction Member
F05 GSC loc. C-177360, Rennell Junction Member
F06 GSC loc. C-177361, Rennell Junction Member
F07 GSC loc. C-177367, Rennell Junction Member
F08 GSC loc. C-177362, Fannin Formation
F09 GSC loc. C-177363, Fannin Formation
F10 GSC loc. C-177364, Fannin Formation
F11 GSC loc. C-177365, Fannin Formation
F12 GSC loc. C-177366, Fannin Formation

SECTION G: RENNELL JUNCTION (Text-figures 3, 13 and 22)

Localities GT1 to GT4 (talus), and G1 to G11 in a stratigraphic sequence measured in a gulley on the east side of the Graham Island main road near its junction with the Rennell Sound road at 53°24′26″N, 132°18′13″W; NTS 103F/8, Yakoun River.

GT1 GSC loc. C-81923, Ghost Creek Formation
GSC loc. C-90574, Ghost Creek Formation
GSC loc. C-90579, GSC types 98668, 98704, Rennell Junction Member
GSC loc. C-90589, Ghost Creek Formation
GT2 GSC loc. C-90573, Rennell Junction Member
GSC loc. C-90604, Rennell Junction Member
GT3 GSC loc. C-81712, GSC types 87792, 98638, 98671, 99047, Rennell Junction Member
GSC loc. C-90587, GSC type 87794, Rennell Junction Member
GSC loc. C-90588, Ghost Creek Formation
GSC loc. C-118697, GSC type 98635, Rennell Junction Member
GT4 GSC loc. C-81927, GSC types 87799, 98596, 98603, 98717, 98719, Fannin Formation
G01 GSC loc. C-81926, GSC type 98666, Ghost Creek Formation
GSC loc. C-90549, GSC type 98663, Ghost Creek Formation
GSC loc. C-90978, GSC type 98658, Ghost Creek Formation
G02 GSC loc. C-81925, Ghost Creek Formation
GSC loc. C-90548, Ghost Creek Formation
GSC loc. C-90556, GSC type 87788, Ghost Creek Formation
GSC loc. C-90591, Ghost Creek Formation
G03 GSC loc. C-81924, Ghost Creek Formation
GSC loc. C-90547, GSC type 98659, Ghost Creek Formation
G04 GSC loc. C-81922, Ghost Creek Formation
GSC loc. C-90572, Ghost Creek Formation
G05 GSC loc. C-90575, Ghost Creek Formation
GSC loc. C-90580, GSC type 98646, Ghost Creek Formation
G06 GSC loc. C-90581, Rennell Junction Member
G07 GSC loc. C-90551, Rennell Junction Member
G08 GSC loc. C-90583, Rennell Junction Member
G09 GSC loc. C-90590, Rennell Junction Member
G10 GSC locs. C-90593, C-90618, Rennell Junction Member
G11 GSC loc. C-90592, Rennell Junction Member

SECTION H: INTERCOAST RESOURCES BOREHOLE DDH-179 (Text-figures 3, 14 and 23)

Localities H1 to H12 in a sequence recovered from a borehole at 53°24′29″N, 132°18′11″W; NTS 103F/8, Yakoun River.

H01 GSC loc. C-90539, Ghost Creek Formation
H02 GSC loc. C-90535, Ghost Creek Formation
H03 GSC loc. C-90640, Ghost Creek Formation
H04 GSC loc. C-90976, Ghost Creek Formation
H05 GSC loc. C-90642, GSC type 98647, Ghost Creek Formation
H06 GSC loc. C-116300, Ghost Creek Formation
H07 GSC loc. C-90534, Rennell Junction Member
H08 GSC loc. C-90611, Rennell Junction Member
H09 GSC loc. C-90641, Rennell Junction Member
H10 GSC loc. C-90538, Rennell Junction Member
H11 GSC loc. C-90530, Rennell Junction Member
H12 GSC loc. C-90610, Rennell Junction Member

ISOLATED LOCALITIES (Text-figures 3 and 24)

Localities I01 to I17 in southern Graham Island; NTS 103F/8, Yakoun River.

I01 53°23′00″N, 132°15′30″W
GSC loc. C-81741, Rennell Junction Member. Ammonites not associated with each other.
I02 53°22′42″N, 132°16′08″W
GSC loc. O-93721, GSC types 98582, 98683, Rennell Junction Member.
GSC loc. O-93725, Rennell Junction Member.
I03 53°23′13″N, 132°16′16″W
GSC loc. C-90560, Fannin Formation
GSC loc. C-90559, GSC type 98747, Fannin Formation
GSC loc. C-90557, Fannin Formation
I04 53°24′11″N, 132°16′08″W
GSC loc. O-93724, Ghost Creek Formation
I05 53°24′29″N, 132°15′41″W
GSC loc. O-93723, GSC type 98712, Fannin Formation
I06 53°24′42″N, 132°14′54″W
GSC loc. C-81709, Fannin Formation
GSC loc. C-90542, GSC types 98587, 98591, 98601, 98602, 98604, 98605, 98612, 98621, 98714, 98720, 98721, 98723, 98743, 99019, 99021, Fannin Formation
GSC loc. C-90552, Fannin Formation
I07 53°24′13″N, 132°18′14″W. From a short stratigraphic interval spanning the contact between the Rennell Junction Member and the Fannin sandstones. Localities 81718 and 177356 are from the same interval at the top of the former; 177355 near the base of the latter.
GSC loc. C-81718, Rennell Junction Member
GSC loc. C-177355, GSC types 99025, 99026, 99028, 99029, 99030, 99031, Fannin Formation.
GSC loc. C-177356, Rennell Junction Member.
I08 53°24′36″N, 132°17′43″W
GSC loc. C-81733, GSC types 87784, 87785, Ghost Creek Formation
GSC loc. C-90974, GSC types 87789, 98699, Ghost Creek Formation
GSC loc. C-90977, GSC types 87783, 87793, 95574, 98652, 98662, 98680, Ghost Creek Formation
GSC loc. C-157551, GSC types 95572, 98700, 98715, 98737, Ghost Creek Formation
I09 53°24′50″N, 132°18′11″W
GSC loc. C-81707, GSC type 98678, Ghost Creek Formation
GSC loc. C-90979, Ghost Creek Formation
I10 53°24′57″N, 132°17′49″W
GSC loc. C-90980, Ghost Creek Formation
I11 53°25′16″N, 132°17′43″W
GSC loc. O-93732, Ghost Creek Formation
I12 53°25′18″N, 132°18′24″W

GSC loc. C-81739, Fannin Formation
I13 53°25′11″N, 132°18′46″W
GSC loc. O-93729, Ghost Creek Formation
I14 53°25′46″N, 132°17′16″W
GSC loc. C-81730, GSC types 98580, 98595, 98618, 98724, Fannin Formation
I15 53°25′45″N, 132°17′19″W
GSC loc. C-90612, Fannin Formation
I16 53°25′45″N, 132°17′22″W
GSC loc. C-81727, Ghost Creek Formation
GSC loc. C-90616, Rennell Junction Member
I17 53°25′34″N, 132°18′30″W
GSC loc. C-81703, GSC types 95577, 98593, 98599, 98606, 98609, 98722, 98725, 98726, Fannin Formation
GSC loc. C-81734, Fannin Formation

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PLATES

EXPLANATION OF PLATE 1

Figures are natural size unless otherwise indicated. The last suture is marked by an arrowhead.

Figure		Page
1.	*Phylloceras bonarellii* Bettoni, 1900.	19
	Hypotype: GSC 98693; Locality: D08 (GSC Loc. O-93564); Ghost Creek Formation, Whiteavesi Zone.	
2,3.	*Phylloceras* sp.	20
	2a,b. Specimen: GSC 98574; Locality: E55 (GSC Loc. O-91827); Fannin Formation, Kunae Zone.	
	3a,b. Specimen: GSC 98575; Locality: ET1 (GSC Loc. O-93743); Fannin Formation, Kunae Zone.	
4,5.	*Cymbites laevigatus* (J. de C. Sowerby, 1827).	24
	4a-d. Hypotype: GSC 98580, a,b ×3; Locality: I14 (GSC Loc. C-81730); Fannin Formation, Kunae Zone.	
	5a-d. Hypotype: GSC 98579, a,b ×3; Locality: ET4 (GSC Loc. O-13628); Fannin Formation, Kunae Zone.	
6.	*Tragophylloceras* new species?	21
	6a,b. Specimen: GSC 98581; Locality: ET4 (GSC Loc. O-93741); Fannin Formation, Kunae Zone.	
7–9.	*Cymbites centriglobus* (Oppel, 1862)	23
	7a-d. Hypotype: GSC 98576, a,b ×3; Locality: ET4 (GSC Loc. O-13628); Fannin Formation, Kunae Zone.	
	8a-d. Hypotype: GSC 98577, a,b ×3; Locality: ET4 (GSC Loc. O-13628); Fannin Formation, Kunae Zone.	
	9a-d. Hypotype: GSC 98578, a,b ×3; Locality: ET4 (GSC Loc. O-48573); Fannin Formation, Kunae Zone.	

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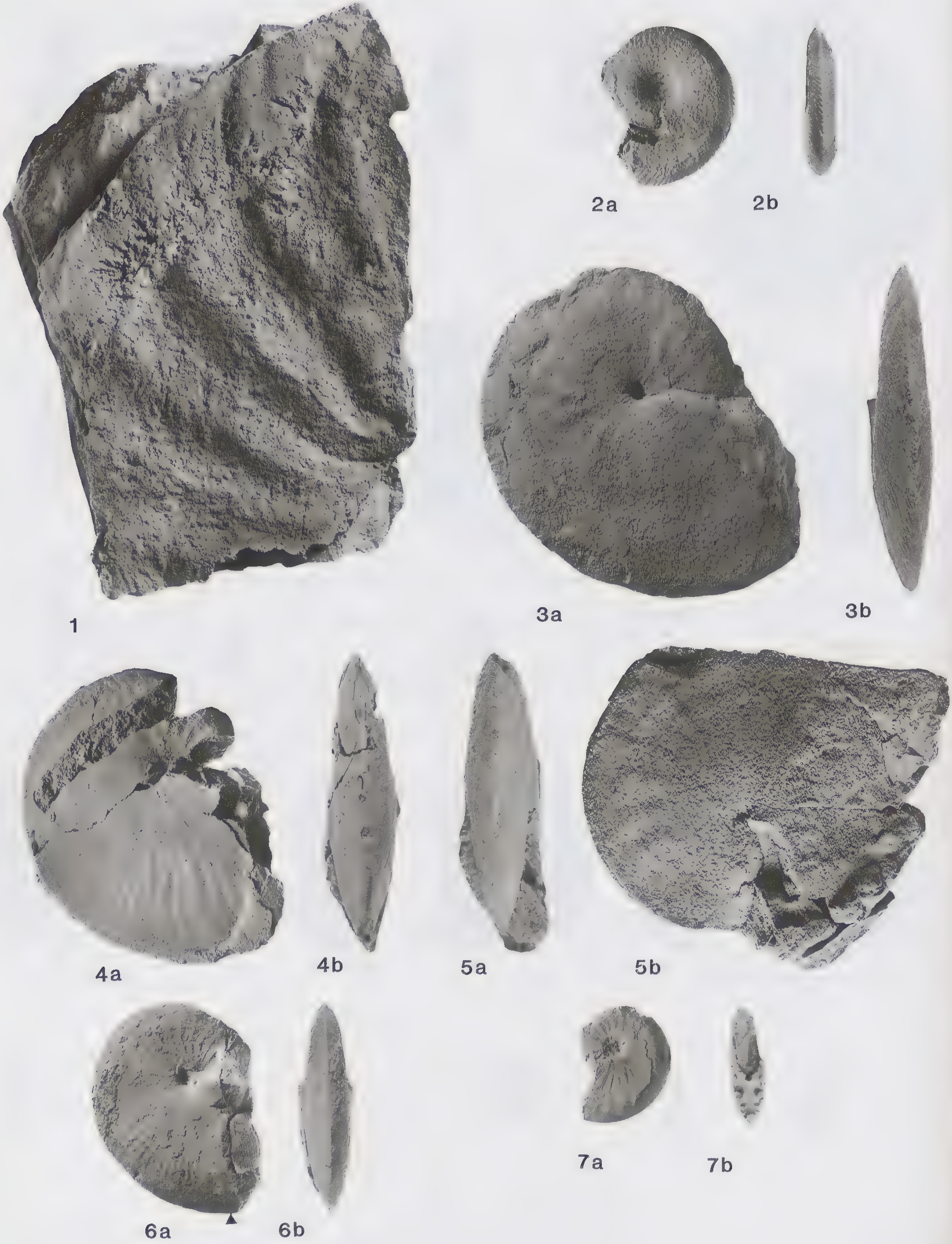
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EXPLANATION OF PLATE 2

All figures are natural size. The last suture is marked by an arrowhead.

Figure — Page

1. *Gleviceras*? sp. 33
   Specimen: GSC 98582; Locality: I02 (GSC Loc. O-93721); Rennell Junction Member, Whiteavesi Zone.
2. *Fanninoceras* (*Fanninoceras*) *bodegae* McLearn, 1932. 27
   2a,b. Holotype: GSC 6518; Locality: ET4 (GSC Loc. C-117032); Fannin Formation, Kunae Zone.

3–7. *Fanninoceras* (*Fanninoceras*) *carlottense* McLearn, 1930. 28

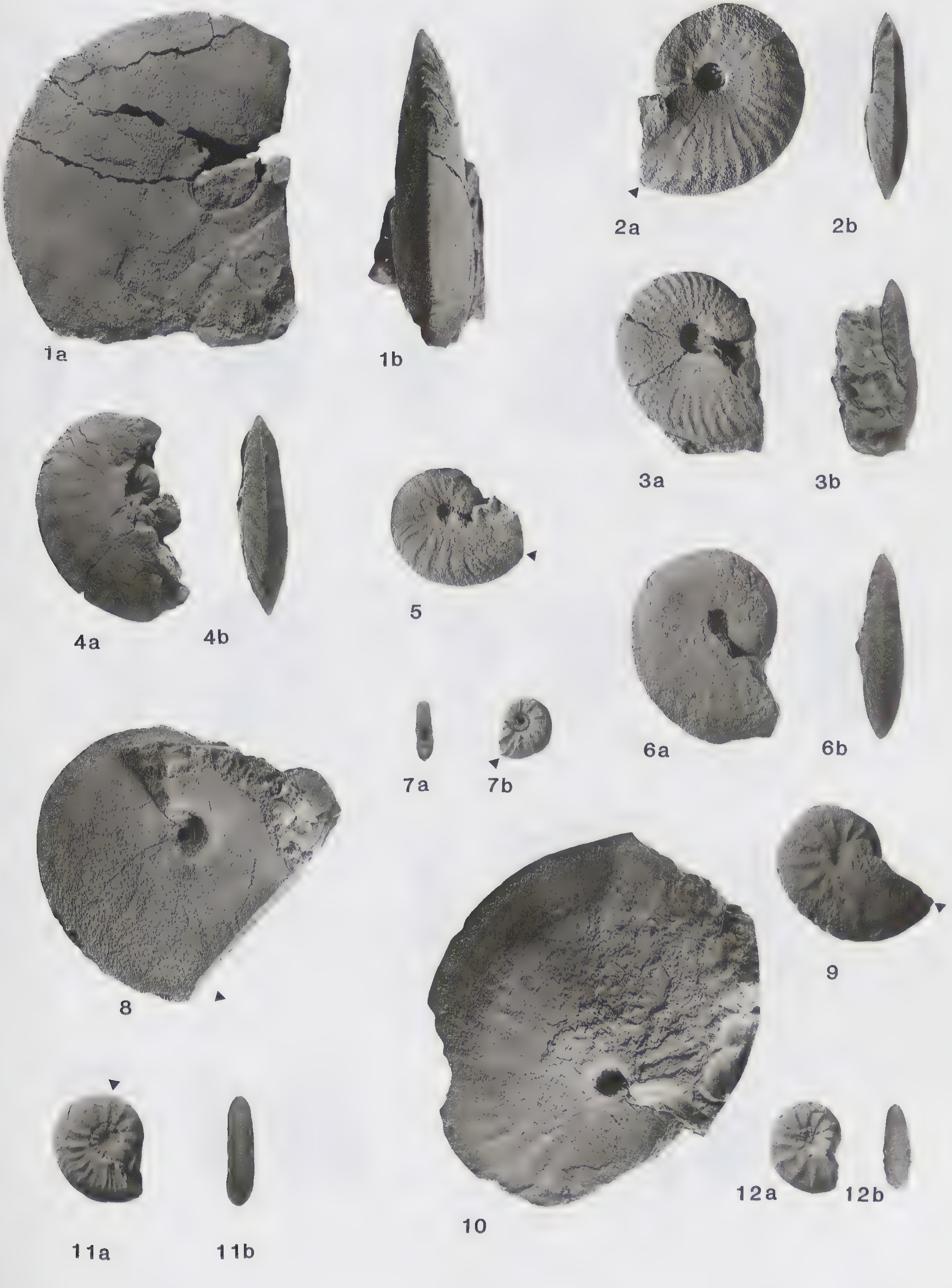
   3a,b. Holotype: GSC 4878; Locality: ET5 (GSC Loc. C-117031); Fannin Formation, Carlottense Zone.
   4a,b. Hypotype: GSC 98585; Locality: ET5 (GSC Loc. C-80834); Fannin Formation, Carlottense Zone.
   5a,b. Hypotype: GSC 98586; Locality: ET5 (GSC Loc. C-80831); Fannin Formation, Carlottense Zone.
   6a,b. Hypotype: GSC 87807; Locality: ET5 (GSC Loc. C-117031); Fannin Formation, Carlottense Zone.
   7a,b. Hypotype: GSC 98600; Locality: E63 (GSC Loc. O-93750); Fannin Formation, Carlottense Zone.

EXPLANATION OF PLATE 3

All figures are natural size. The last suture is marked by an arrowhead.

Figure | Page
1–12. *Fanninoceras* (*Fanninoceras*) *fannini* McLearn, 1930. 29

1a,b. Plesiotype of McLearn (1932): GSC 6495; Locality: ET4 (GSC Loc. C-117032); Fannin Formation, Kunae Zone.
2a,b. Holotype: GSC 9054; Locality: ET4 (GSC Loc. C-117032); Fannin Formation, Kunae Zone.
3a,b. Holotype of *F. dolmagii* McLearn, 1932: GSC 6519; Locality: ET4 (GSC Loc. C-117034); Fannin Formation, Kunae Zone.
4a,b. Plesiotype of McLearn (1932): GSC 6494; Locality: ET4 (GSC Loc. C-117032); Fannin Formation, Kunae Zone.
5. Hypotype: GSC 98594; Locality: ET4 (GSC Loc. O-13628); Fannin Formation, Kunae Zone.
6a,b. Plesiotype of McLearn (1932): GSC 6493; Locality: ET4 (GSC Loc. C-117032); Fannin Formation, Kunae Zone.
7a,b. Hypotype: GSC 98596; Locality: GT4 (GSC Loc. C-81927); Fannin Formation, Kunae Zone.
8. Hypotype: GSC 98597; Locality: ET4 (GSC Loc. C-80839); Fannin Formation, Kunae Zone.
9. Hypotype: GSC 98598; Locality: ET5 (GSC Loc. C-80814); Fannin Formation, Carlottense? Zone.
10. Hypotype: GSC 87799; Locality: GT4 (GSC Loc. C-81927); Fannin Formation, Kunae Zone.
11a,b. Hypotype: GSC 98588; Locality: E63 (GSC Loc. O-93750); Fannin Formation, Carlottense Zone.
12a,b. Hypotype: GSC 98694; Locality: ET5 (GSC Loc. C-80832); Fannin Formation, Carlottense Zone.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EXPLANATION OF PLATE 4

All figures are natural size. The last suture is marked by an arrowhead.

Figure — Page

1–4. *Fanninoceras* (*Fanninoceras*) *crassum* McLearn, 1932. 28

- 1a,b. Paratype: GSC 6517; Locality: ET4 (GSC Loc. C-117032); Fannin Formation, Kunae Zone.
- 2a,b. Holotype: GSC 6496; Locality: ET4 (GSC Loc. C-117032); Fannin Formation, Kunae Zone.
- 3a-c. Hypotype: GSC 98603; Locality: GT4 (GSC Loc. C-81927); Fannin Formation, Kunae Zone.
- 4a,b. Hypotype: GSC 87798; Locality: ET4 (GSC Loc. O-48573); Fannin Formation, Kunae Zone.

5–8,11,12. *Fanninoceras* (*Fanninoceras*) *kunae* McLearn, 1930. 30

- 5a,b. Plesiotype of McLearn (1932): GSC 6670; Locality: ET4 (GSC Loc. C-117034); Fannin Formation, Kunae Zone.
- 6a-c. Holotype: GSC 4876c; Locality: ET4 (GSC Loc. C-117034); Fannin Formation, Kunae Zone.
- 7a,b. Hypotype: GSC 98607; Locality: E55 (GSC Loc. O-91827); Fannin Formation, Kunae Zone.
- 8a,b. Hypotype: GSC 98608; Locality: ET4 (GSC Loc. C-81724); Fannin Formation, Kunae Zone.
- 11a,b. Holotype of *F. lowrii* McLearn, 1930: GSC 9055; Locality: ET4 (GSC Loc. C-117034); Fannin Formation, Kunae Zone.
- 12. Hypotype: GSC 98612; Locality: I06 (GSC Loc. C-90542); Fannin Formation, Kunae Zone.

9,10. *Fanninoceras* (*Fanninoceras*) *latum* McLearn, 1930. 31

- 9a,b. Holotype: GSC 9058; Locality: ET4 (GSC Loc. C-117032); Fannin Formation, Kunae Zone.
- 10a,b. Hypotype: GSC 98610; Locality: ET4 (GSC Loc. C-80839); Fannin Formation, Kunae Zone.

13. *Fanninoceras* (*Fanninoceras*) sp. 1. 31

- 13a,b. Specimen: GSC 98589; Locality: ET5 (GSC Loc. C-117005); Fannin Formation, Carlottense Zone.

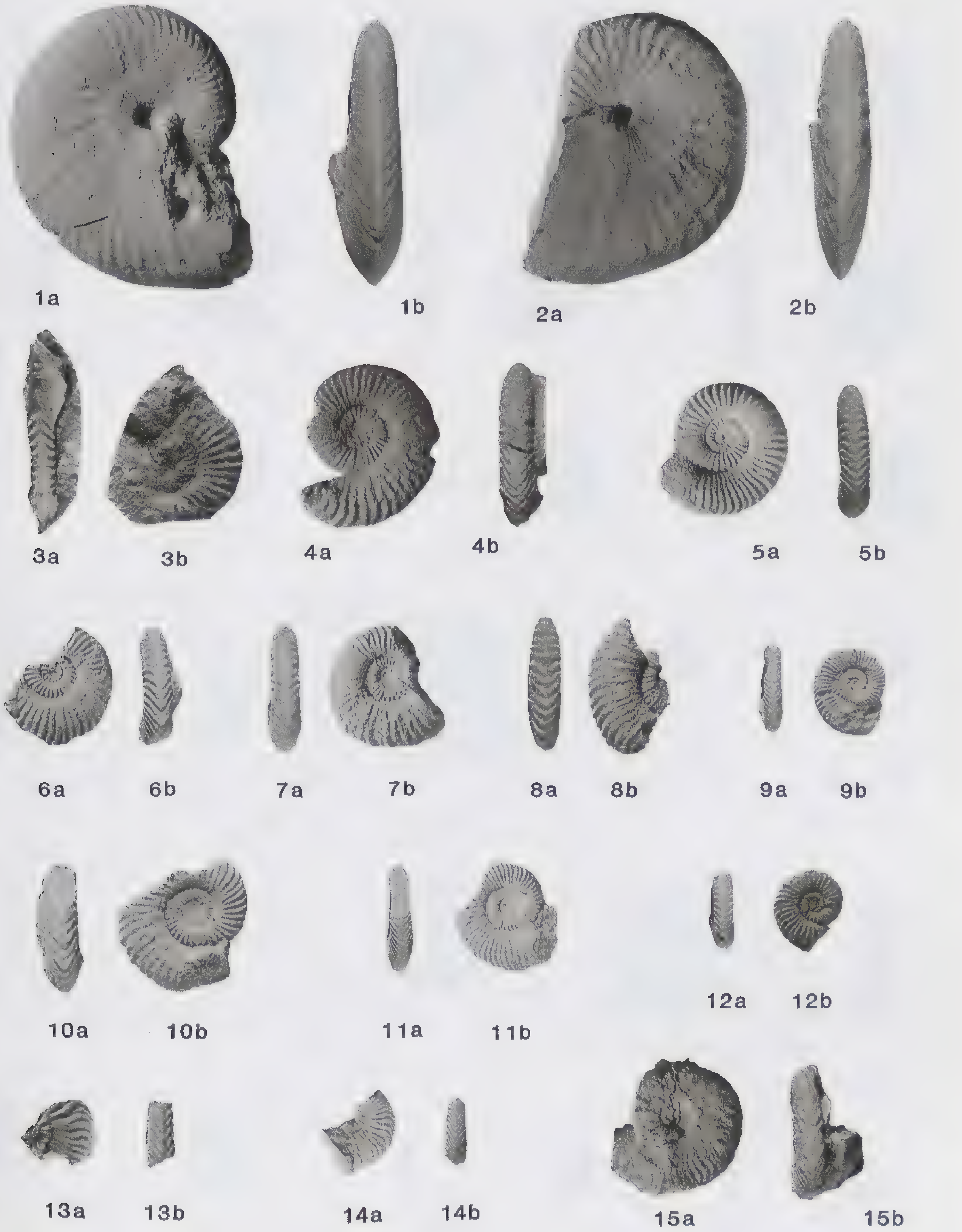
14. *Fanninoceras* (*Fanninoceras*) sp. 2. 32

- 14a-c. Specimen: GSC 98613; Locality: E63 (GSC Loc. C-90545); Fannin Formation, Carlottense Zone.

EXPLANATION OF PLATE 5

All figures are natural size.

Figure		Page
1,2.	*Fanninoceras* (*Fanninoceras*) *fannini* McLearn, 1930.	29
	1a,b. Hypotype: GSC 99030; Locality: I07 (GSC Loc. C-177355); Fannin Formation, Kunae Zone.	
	2a,b. Hypotype: GSC 99031; Locality: I07 (GSC Loc. C-177355); Fannin Formation, Kunae Zone.	
3–12.	*Oistoceras compressum,* new species.	53
	3a,b. Paratype: GSC 98625; Locality: ET3 (GSC Loc. C-80840); Rennell Junction Member, Whiteavesi or Freboldi Zone.	
	4a,b. Paratype: GSC 98696; Locality: FT1 (GSC Loc. C-156675); Rennell Junction Member, Freboldi Zone.	
	5a,b. Holotype: GSC 99039; Locality: FT1 (GSC Loc. C-177370); Rennell Junction Member, Whiteavesi or Freboldi Zone.	
	6a,b. Paratype: GSC 98710; Locality: FT1 (GSC Loc. C-156675); Rennell Junction Member, Freboldi Zone.	
	7a,b. Paratype: GSC 98738; Locality: FT1 (GSC Loc. C-156675); Rennell Junction Member, Freboldi Zone.	
	8a,b. Paratype: GSC 99027; Locality: FT1 (GSC Loc. C-156675); Rennell Junction Member, Freboldi Zone.	
	9a,b. Paratype: GSC 99038; Locality: FT1 (GSC Loc. C-156675); Rennell Junction Member, Freboldi Zone.	
	10a,b. Paratype: GSC 99041; Locality: FT1 (GSC Loc. C-156675); Rennell Junction Member, Freboldi Zone.	
	11a,b. Paratype: GSC 99042; Locality: FT1 (GSC Loc. C-156675); Rennell Junction Member, Freboldi Zone.	
	12a,b. Paratype: GSC 99043; Locality: FT1 (GSC Loc. C-156675); Rennell Junction Member, Freboldi Zone.	
13–15.	*Fanninoceras* (*Charlotticeras*) *carteri,* new species.	32
	13a,b. Paratype: GSC 99029; Locality: I07 (GSC Loc. C-177355); Fannin Formation, Kunae Zone.	
	14a,b. Paratype: GSC 99028; Locality: I07 (GSC Loc. C-177355); Fannin Formation, Kunae Zone.	
	15a,b. Paratype: GSC 99026; Locality: I07 (GSC Loc. C-177355); Fannin Formation, Kunae Zone.	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EXPLANATION OF PLATE 6

All figures are natural size.

Figure | Page

1–5. *Fanninoceras* (*Charlotticeras*) *carteri*, new species. 32
- 1a,b. Holotype: GSC 98614; Locality: E57 (GSC Loc. C-80234); Fannin Formation, Kunae Zone.
- 2. Paratype: GSC 98615 (latex cast); Locality: E57 (GSC Loc. C-80234); Fannin Formation, Kunae Zone.
- 3. Paratype: GSC 98616 (latex cast); Locality: E57 (GSC Loc. C-80234); Fannin Formation, Kunae Zone.
- 4. Paratype: GSC 98617; Locality: E57 (GSC Loc. C-80234); Fannin Formation, Kunae Zone.
- 5a,b. Paratype: GSC 98618; Locality: I14 (GSC Loc. C-81730); Fannin Formation, Kunae Zone.

6–11. *Fanninoceras* (*Charlotticeras*) *maudense*, new species. 32
- 6a,b. Paratype: GSC 98619; Locality: D20 (GSC Loc. C-80765); Fannin Formation, Kunae Zone.
- 7a,b. Holotype: GSC 98620; Locality: D20 (GSC Loc. C-80765); Fannin Formation, Kunae Zone.
- 8a,b. Paratype: GSC 98621; Locality: I06 (GSC Loc. C-90542); Fannin Formation, Kunae Zone.
- 9a,b. Paratype: GSC 98622; Locality: ET4 (GSC Loc. O-93741); Fannin Formation, Kunae Zone.
- 10a,b. Paratype: GSC 98623; Locality: E56 (GSC Loc. C-80233); Fannin Formation, Kunae Zone.
- 11a,b. Paratype: GSC 98624; Locality: E57 (GSC Loc.C-80234); Fannin Formation, Kunae Zone.

12–14. *Gemmellaroceras* sp. 34
- 12. Specimen: GSC 99024; Locality: FT1 (GSC Loc. C-177370); Rennell Junction Member, Freboldi Zone.
- 13a,b. Specimen: GSC 99022; Locality: FT1 (GSC Loc. C-177370); Rennell Junction Member, Freboldi Zone.
- 14. Specimen: GSC 99023; Locality: FT1 (GSC Loc. C-177370); Rennell Junction Member, Freboldi Zone.

15–18. *Polymorphites confusus* (Quenstedt, 1856). 35
- 15. Hypotype: GSC 98626; Locality: B04 (GSC Loc. C-117019); Rennell Junction Member, Whiteavesi Zone.
- 16a,b. Hypotype: GSC 98627; Locality: B04 (GSC Loc. C-117019); Rennell Junction Member, Whiteavesi Zone.
- 17a,b. Hypotype: GSC 98628; Locality: B04 (GSC Loc. C-117019); Rennell Junction Member, Whiteavesi Zone.
- 18. Hypotype: GSC 98629; Locality: B04 (GSC Loc. C-117019); Rennell Junction Member, Whiteavesi Zone.

19–23. *Gemmellaroceras aenigmaticum* (Gemmellaro, 1884). 34
- 19a,b. Hypotype: GSC 98630; Locality: B04 (GSC Loc. C-117019); Rennell Junction Member, Whiteavesi Zone.
- 20a,b. Hypotype: GSC 98631; Locality: ET1 (GSC Loc. O-48603).
- 21a,b. Hypotype: GSC 98632; Locality: ET1 (GSC Loc. O-48603).
- 22. Hypotype: GSC 98633; Locality: B04 (GSC Loc. C-117019); Rennell Junction Member, Whiteavesi Zone.
- 23. Hypotype: GSC 95575; Locality: B04 (GSC Loc. C-117019); Rennell Junction Member, Whiteavesi Zone.

EXPLANATION OF PLATE 7

All figures are natural size. The last suture is marked by an arrowhead.

Figure		Page
1–5.	*Acanthopleuroceras thomsoni*, new species.	36
	1a,b. Paratype: GSC 98635 (latex cast); Locality: GT3 (GSC Loc. C-118697); Rennell Junction Member.	
	2a,b. Paratype: GSC 98636; Locality: B04 (GSC Loc. C-117019); Rennell Junction Member, Whiteavesi Zone.	
	3a,b. Paratype: GSC 98637; Locality: B04 (GSC Loc. C-117019); Rennell Junction Member, Whiteavesi Zone.	
	4a,b. Holotype: GSC 98638; Locality: GT3 (GSC Loc. C-81712); Rennell Junction Member.	
	5a,b. Paratype: GSC 98639; Locality: B04 (GSC Loc. C-117019); Rennell Junction Member, Whiteavesi Zone.	
6–10.	*Acanthopleuroceras whiteavesi* Smith and Tipper, 1988.	36
	6a,b. Paratype: GSC 87791; Locality: E27 (GSC Loc. O-91794); Rennell Junction Member, Whiteavesi Zone.	
	7a,b. Holotype: GSC 87790; Locality: E27 (GSC Loc. O-91794); Rennell Junction Member, Whiteavesi Zone.	
	8a,b. Hypotype: GSC 87811; Locality: ET1 (GSC Loc. C-80836).	
	9a,b. Hypotype: GSC 87810; Locality: ET1 (GSC Loc. O-48603).	
	10a,b. Hypotype: GSC 98653; Locality: E27 (GSC Loc. O-91794); Rennell Junction Member, Whiteavesi Zone.	

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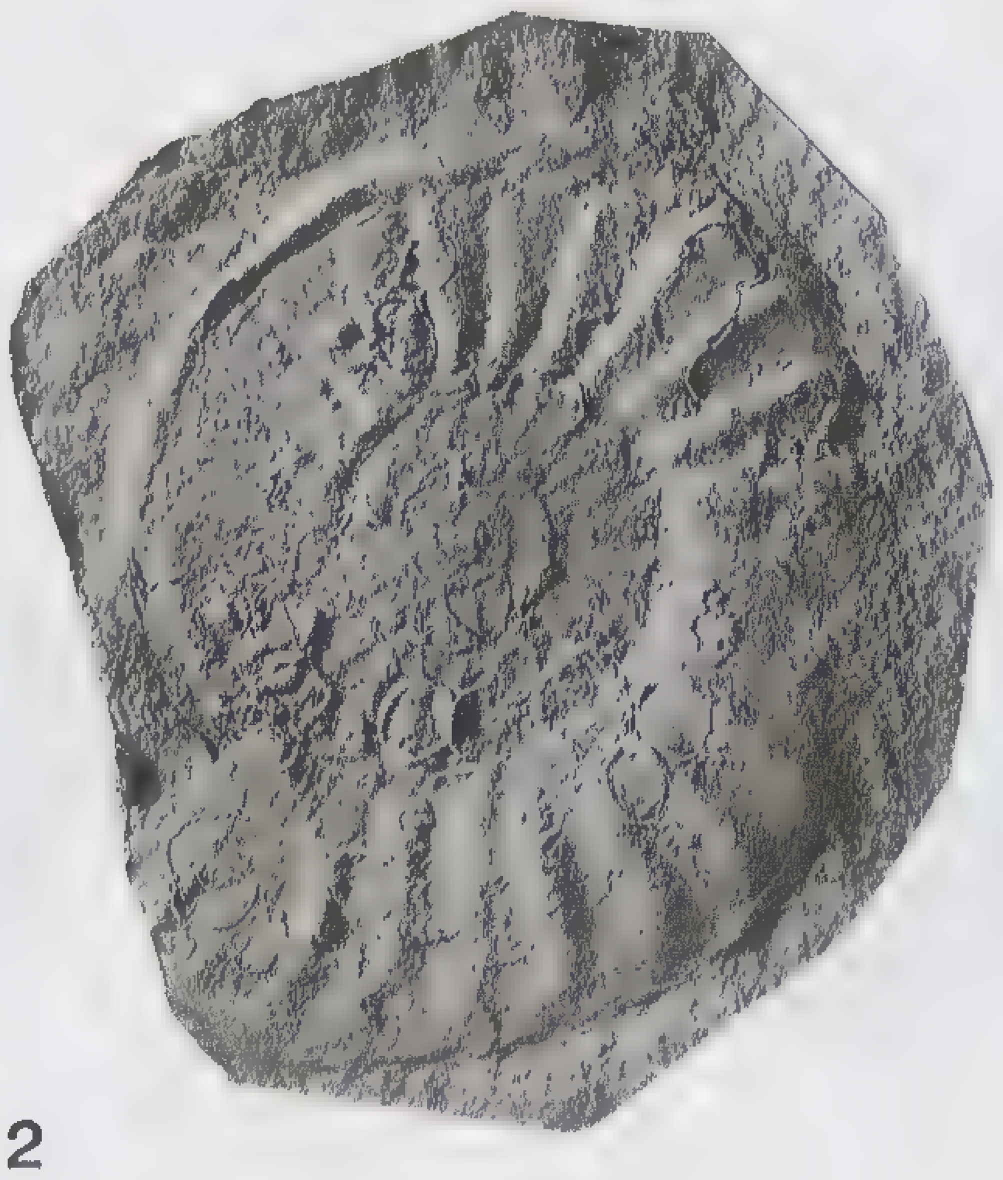
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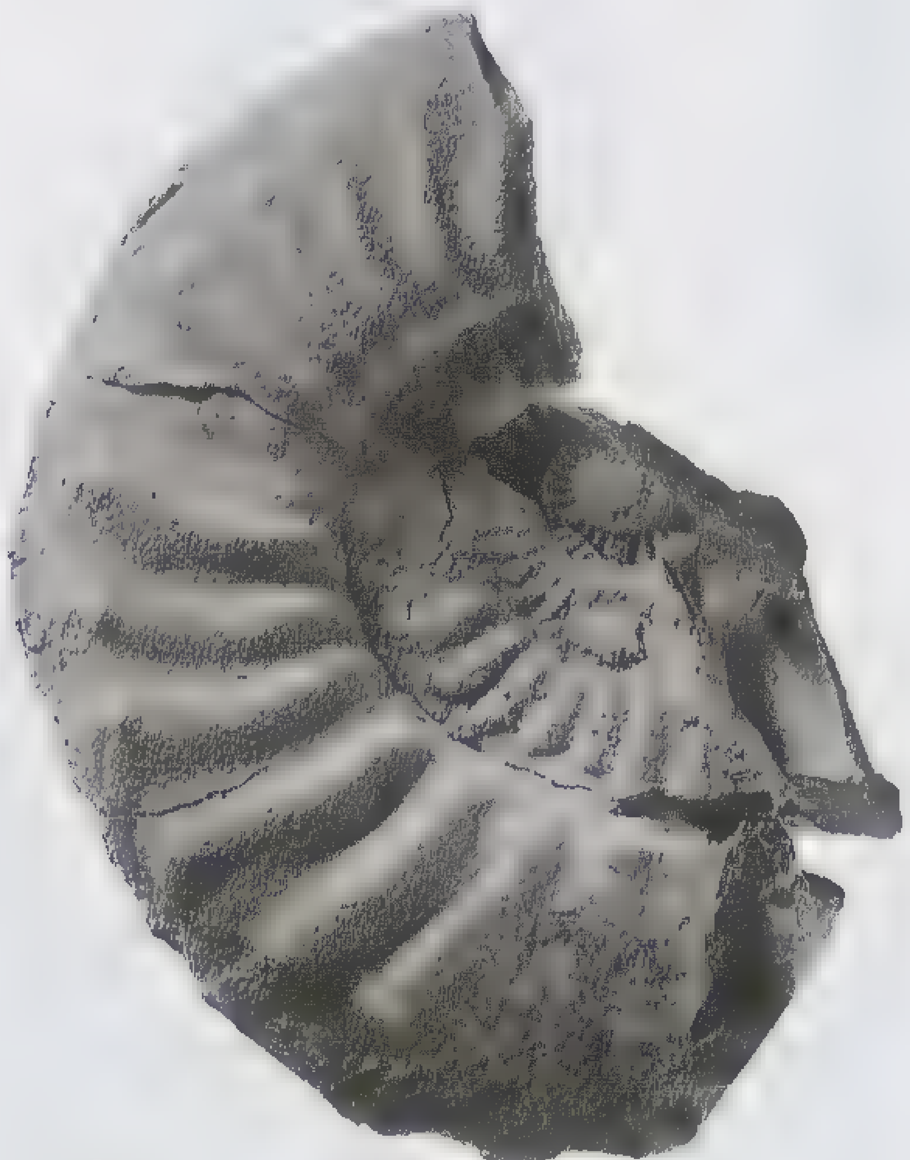
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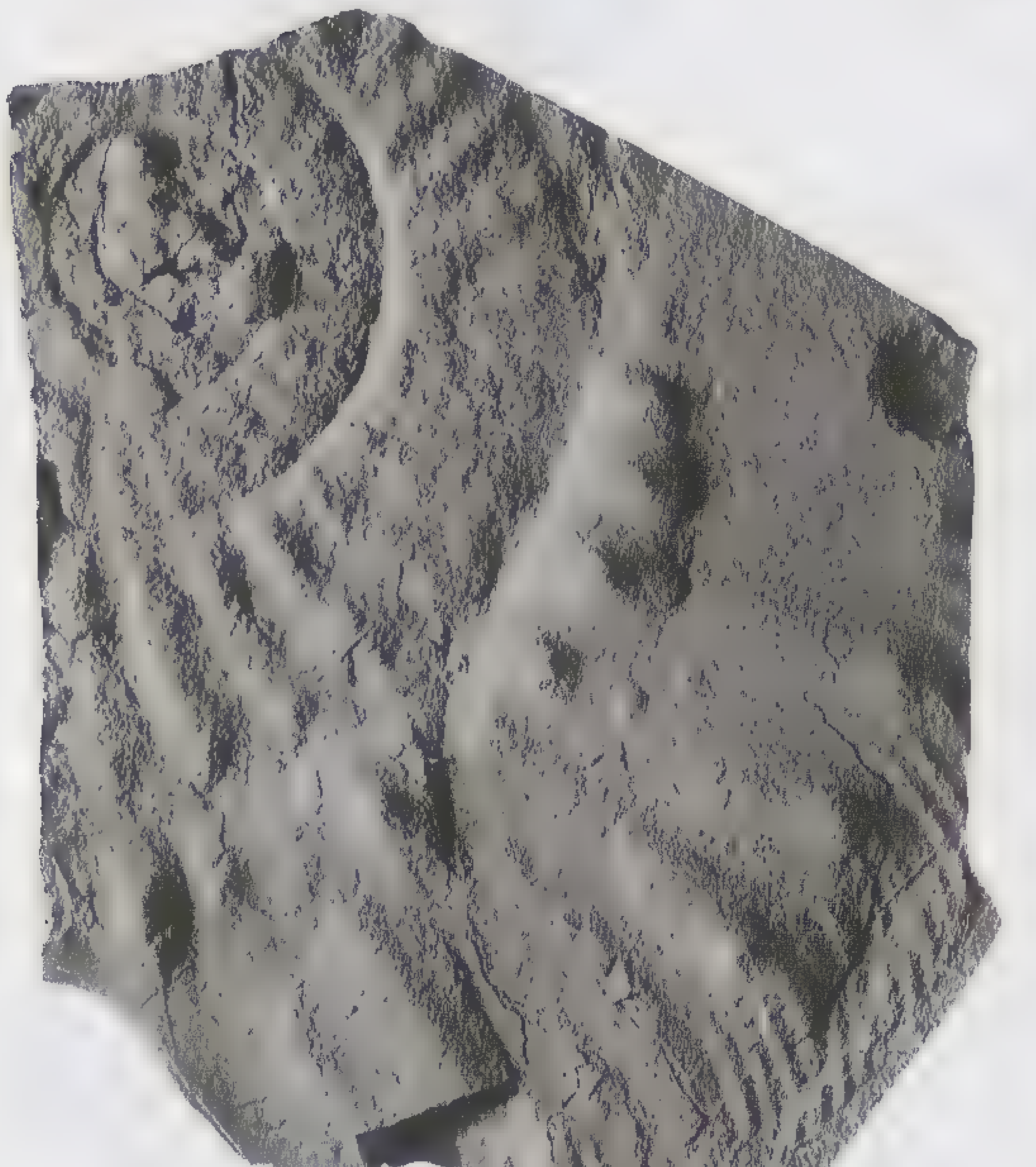
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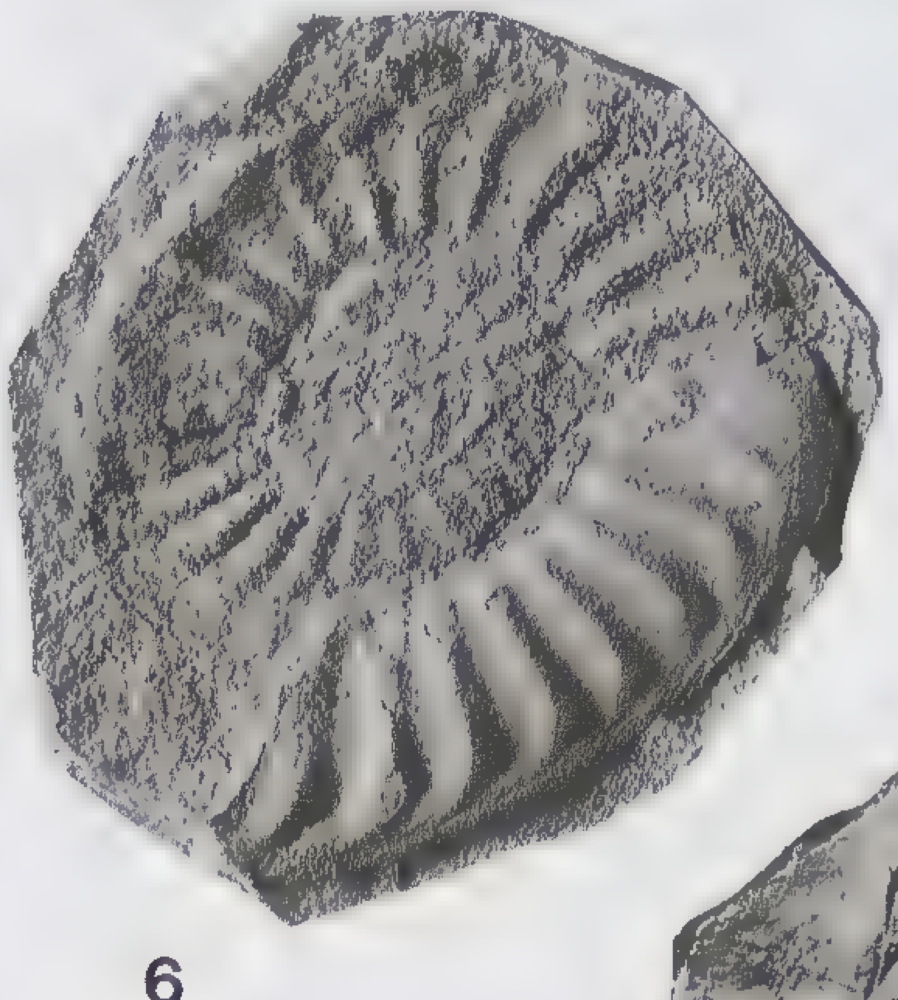
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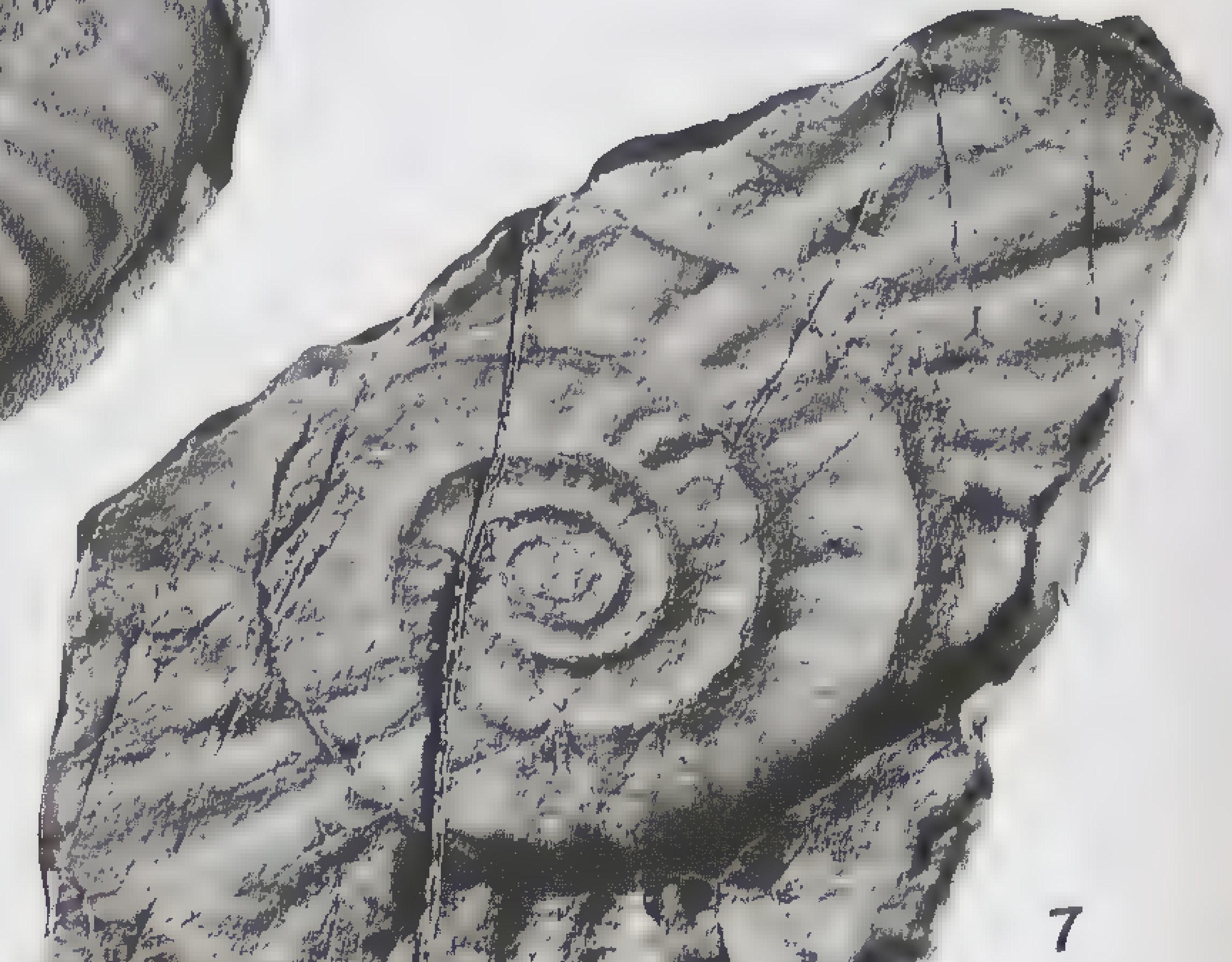
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EXPLANATION OF PLATE 8

All figures are natural size.

Figure | Page
1–3,6. *Tropidoceras actaeon* (d'Orbigny, 1844). 37
1a,b. Hypotype: GSC 98645; Locality: D11 (GSC Loc. C-80755); Ghost Creek Formation, Whiteavesi Zone.
2. Hypotype: GSC 98646 (latex cast); Locality: G05 (GSC Loc. C-90580); Ghost Creek Formation, Whiteavesi Zone.
3. Hypotype: GSC 98647; Well core sample: H05 (GSC Loc. C-90642); Ghost Creek Formation, Whiteavesi Zone.
6. Hypotype: GSC 98695 (latex cast); Locality: D07 (GSC Loc. C-80249); Ghost Creek Formation, Whiteavesi Zone.
4. *Tropidoceras* new species 1. 40
4a,b. Specimen: GSC 98648; Locality: E34 (GSC Loc. O-91814); Rennell Junction Member, Whiteavesi Zone.
5. *Tropidoceras flandrini obtusa* (Futterer, 1893). 38
Hypotype: GSC 98699; Locality: I08 (GSC Loc. C-90974); Ghost Creek Formation, Imlayi Zone.
7. *Tropidoceras* aff. *rursicosta* (Buckman, 1918). 39
Specimen: GSC 98650 (latex cast); Locality: E01 (GSC Loc. C-80241); Ghost Creek Formation, Imlayi Zone.

EXPLANATION OF PLATE 9

All figures are natural size.

Figure		Page
1–2,4.	*Tropidoceras flandrini flandrini* (Dumortier, 1869).	38
	1. Hypotype: GSC 87793 (latex cast); Locality: I08 (GSC Loc. C-90977); Ghost Creek Formation, Imlayi Zone;	
	2. Hypotype: GSC 98652 (latex cast); Locality: I08 (GSC Loc. C-90977); Ghost Creek Formation, Imlayi Zone.	
	4. Hypotype: GSC 95574; Locality: I08 (GSC Loc. C-90977); Ghost Creek Formation, Imlayi Zone.	
3,5.	*Tropidoceras flandrini obtusa* (Futterer, 1893).	38
	3a,b. Hypotype: GSC 99044 (a = latex cast); Locality: D08 (GSC Loc. O-93564); Ghost Creek Formation, Whiteavesi Zone.	
	5. Hypotype: GSC 98654 (latex cast); Locality: D08 (GSC Loc. O-93564); Ghost Creek Formation, Whiteavesi Zone.	

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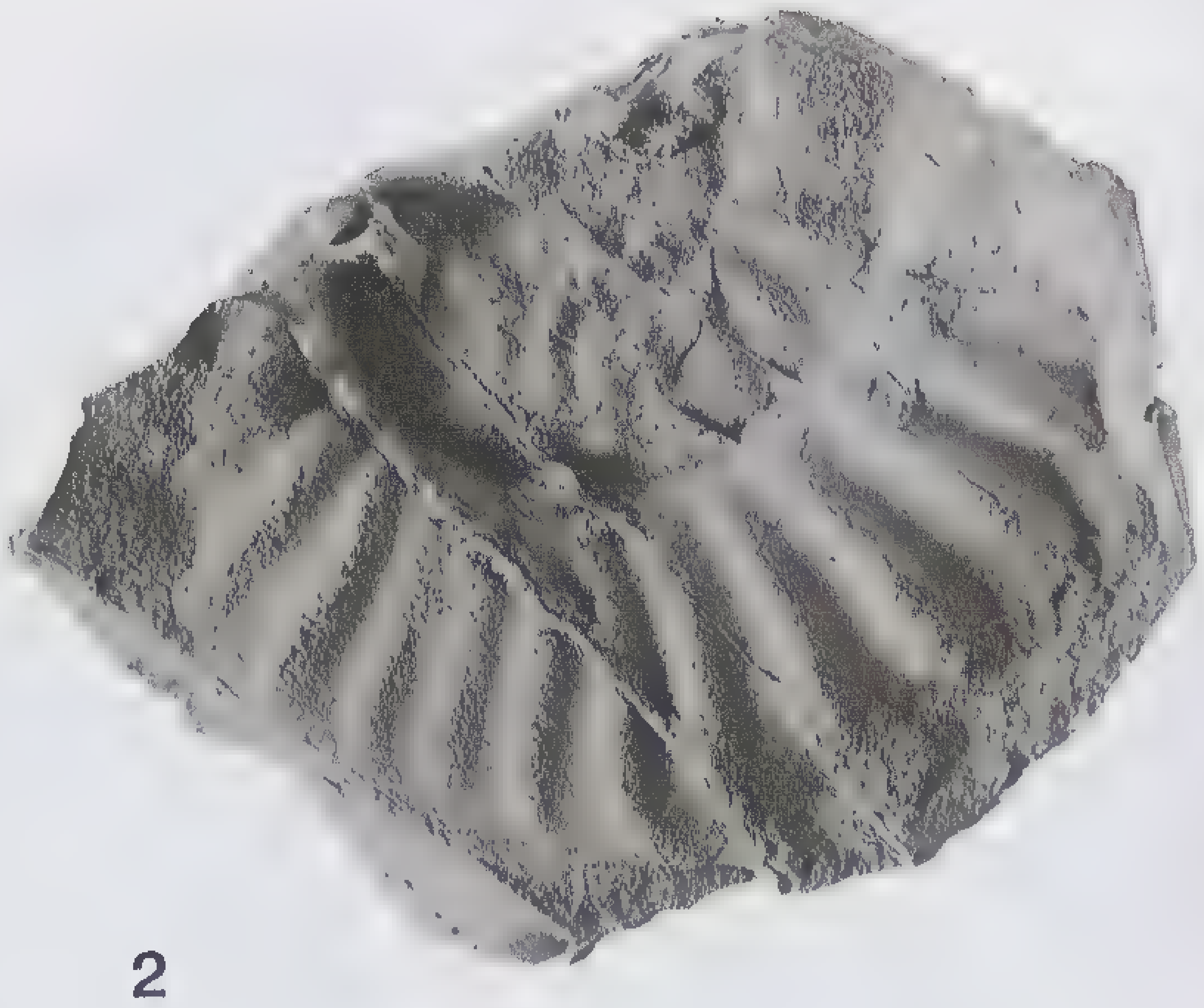
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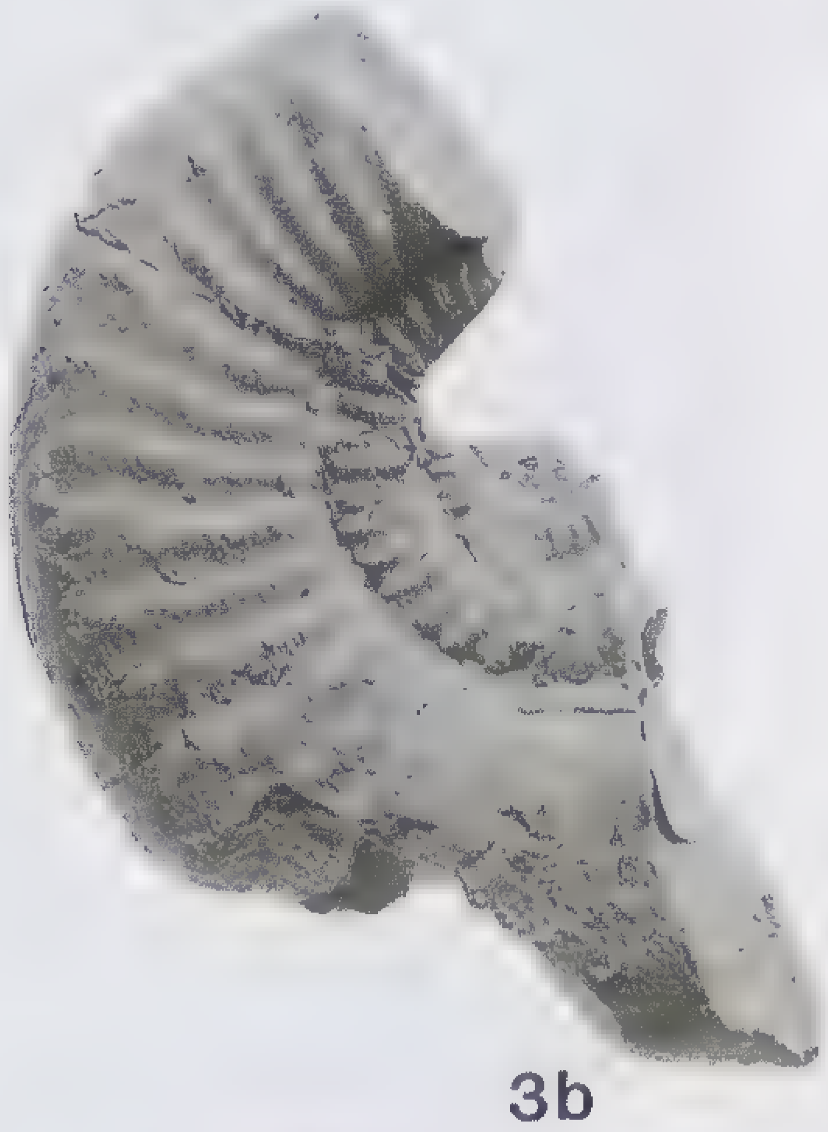
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EXPLANATION OF PLATE 10

All figures are natural size.

Figure | Page
1,2. *Tropidoceras masseanum rotunda* (Futterer, 1893). 39
1. Hypotype: GSC 95573; Locality: D11 (GSC Loc. O-93575); Ghost Creek Formation, Whiteavesi Zone.
2. Hypotype: GSC 98656 (latex cast); Locality: D06 (GSC Loc. C-80246); Ghost Creek Formation, Whiteavesi Zone.

3. *Tropidoceras* new species 2. 40
3a,b. Specimen: GSC 98657; Locality: ET1 (GSC Loc. C-80836).

4,7. *Tropidoceras* cf. *erythraeum* (Gemmellaro, 1884). 38
4. Specimen: GSC 98658 (latex cast); Locality: G01 (GSC Loc. C-90978); Ghost Creek Formation, Imlayi Zone.
7. Specimen: GSC 87788 (latex cast); Locality: G02 (GSC Loc. C-90556); Ghost Creek Formation, Imlayi Zone.

5,6. *Gemmellaroceras* cf. *alloplocum* (Gemmellaro, 1884). 34
5. Specimen: GSC 98659 (latex cast); Locality: G03 (GSC Loc. C-90547); Ghost Creek Formation, Imlayi Zone.
6. Specimen: GSC 98660; Locality: E13 (GSC Loc. C-80329); Ghost Creek Formation, Imlayi Zone.

EXPLANATION OF PLATE 11

All figures are natural size.

Figure		Page
1–3.	*Tropidoceras* species 1.	40
	1. Specimen: GSC 98662; Locality: I08 (GSC Loc. C-90977); Ghost Creek Formation, Imlayi Zone.	
	2. Specimen: GSC 98663 (latex cast); Locality: G01 (GSC Loc. C-90549); Ghost Creek Formation, Imlayi Zone.	
	3. Specimen: GSC 98664 (latex cast); Locality: E20 (GSC Loc. O-91803); Rennell Junction Member, Whiteavesi Zone.	
4–6.	*Miltoceras* aff. *sellae* (Gemmellaro, 1884).	42
	4. Specimen: GSC 98665; Locality: E14 (GSC Loc. C-80330); Ghost Creek Formation, Imlayi Zone.	
	5. Specimen: GSC 98666; Locality: G01 (GSC Loc. C-81926); Ghost Creek Formation, Imlayi Zone.	
	6. Specimen: GSC 98667; Locality: ET1 (GSC Loc. O-93577).	
7,8.	*Reynesocoeloceras* spp.	50
	7. Specimen: GSC 98668 (latex cast); Locality: GT1 (GSC Loc. C-90579); Rennell Junction Member.	
	8. Specimen: GSC 98669; Locality: E40 (GSC Loc. C-80350); Rennell Junction Member, Whiteavesi Zone.	

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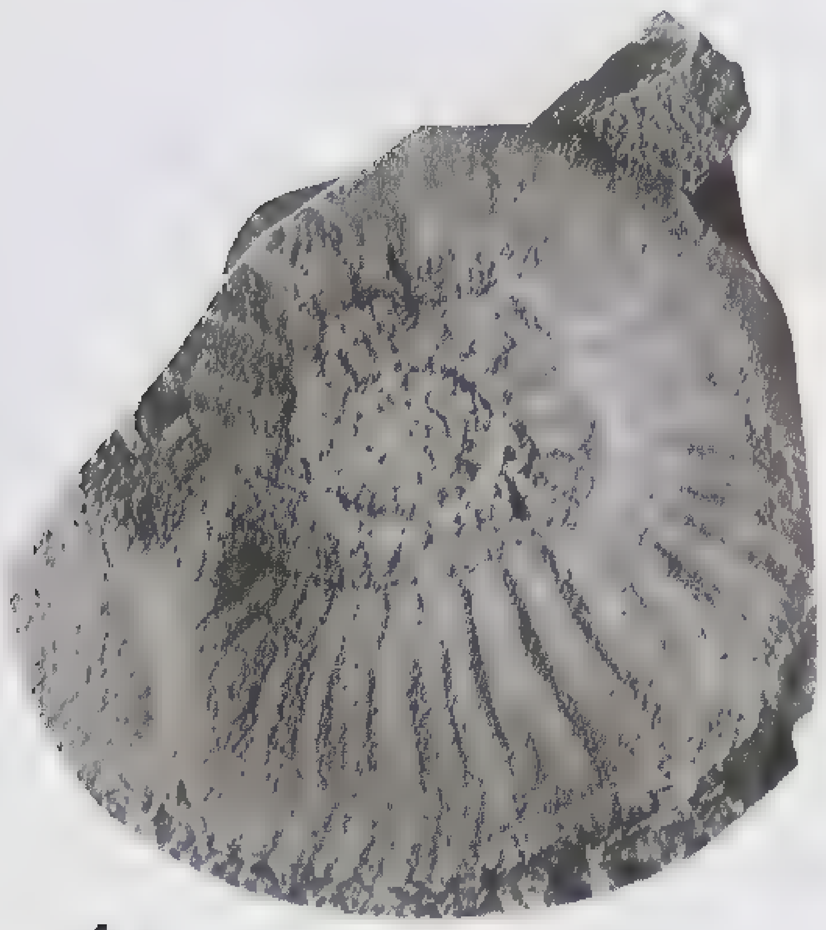

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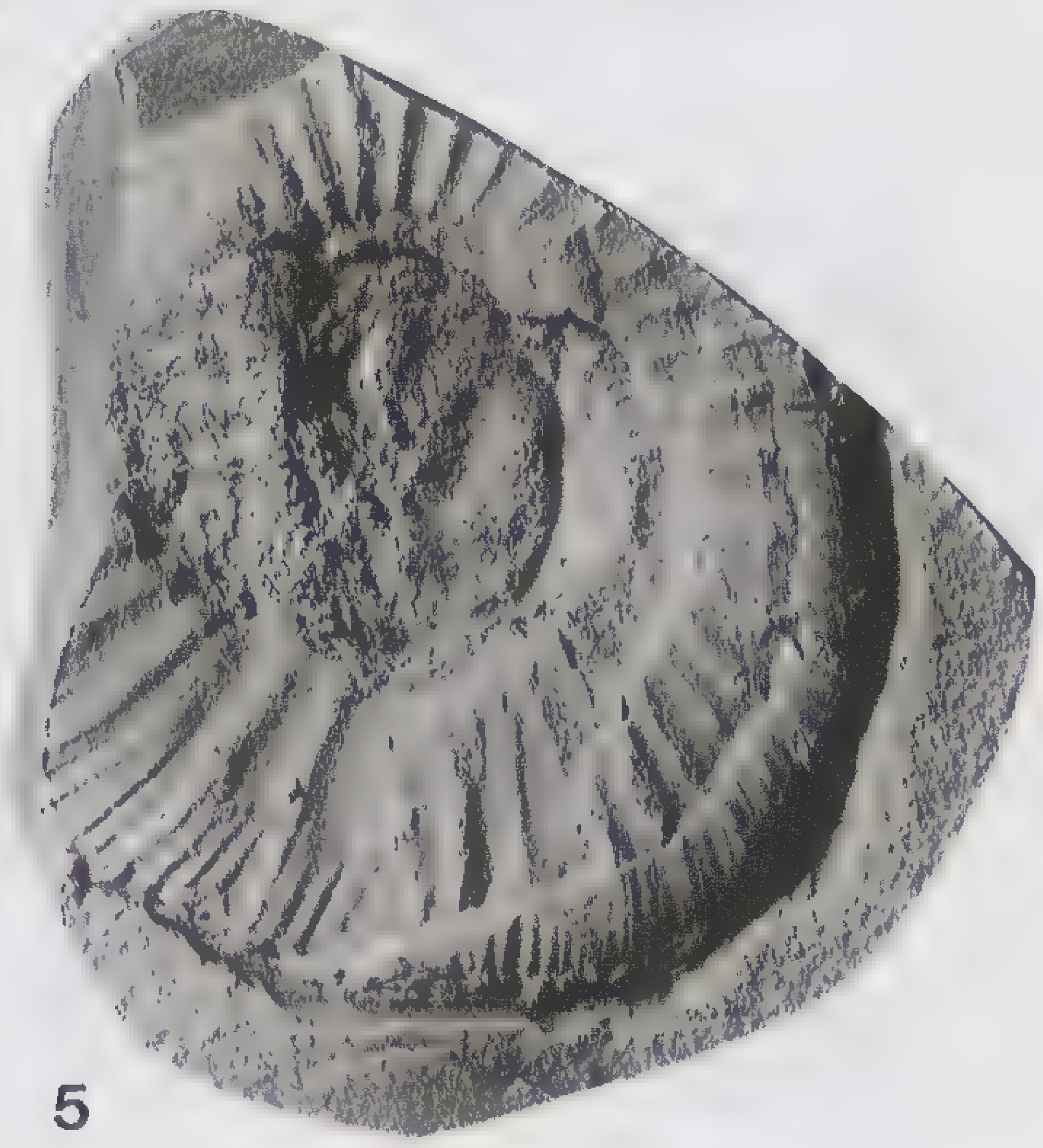

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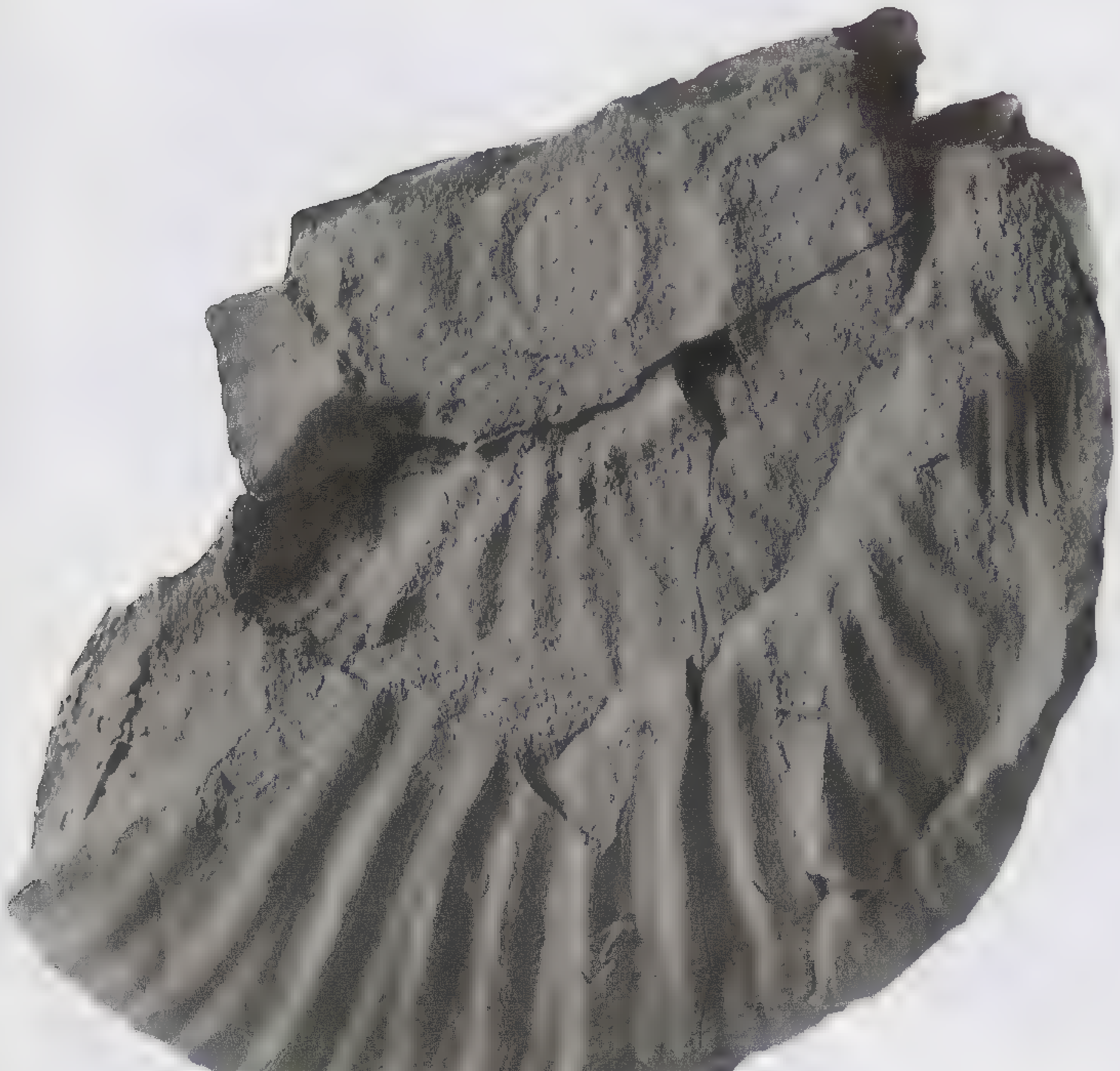

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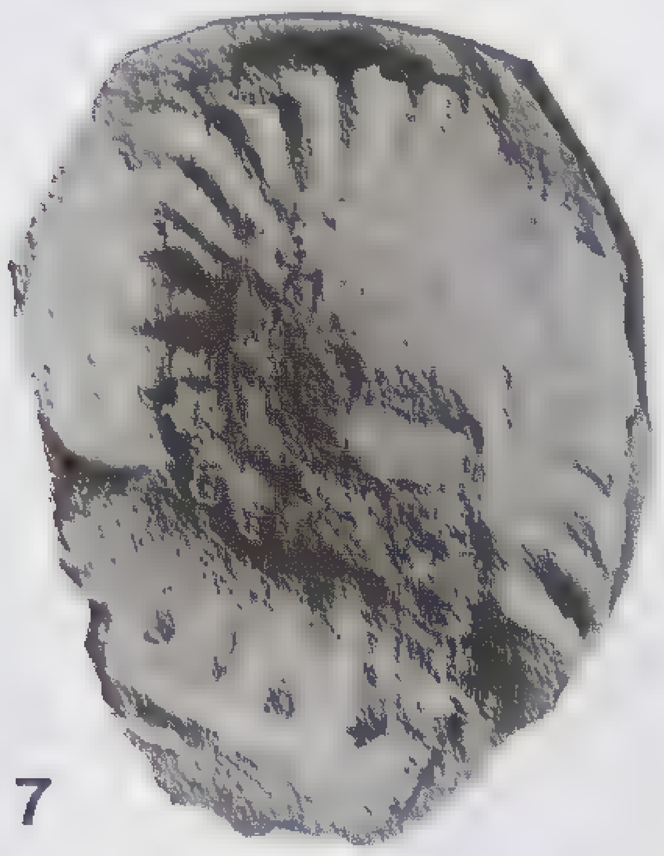

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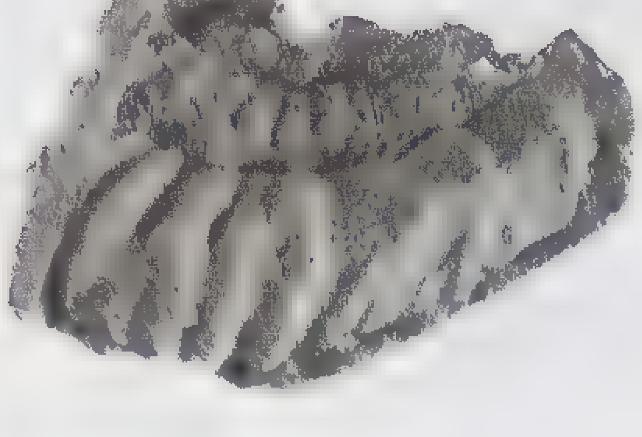

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EXPLANATION OF PLATE 12

All figures are natural size. The last suture is marked by an arrowhead.

Figure		Page
1.	*Reynesocoeloceras* cf. *incertum* (Fucini, 1905).	49
1a,b. Specimen: GSC 98670 (latex cast); Locality: E51 (GSC Loc. C-117284); Fannin Formation, basal Kunae Zone.
2,5,6.	*Reynesocoeloceras grahami,* new species.	49
2a,b. Holotype: GSC 98671; Locality: FT1 (GSC Loc. C-177370); Rennell Junction Member, Freboldi Zone.
5. Paratype: GSC 98651; Locality: FT1 (GSC Loc. C-177370); Rennell Junction Member, Freboldi Zone.
6a,b. Paratype: GSC 87809; Locality: FT1 (GSC Loc. C-177370); Rennell Junction Member, Freboldi Zone.
3,4,7,8.	*Reynesocoeloceras mortilleti* (Meneghini, 1875).	49
3a,b. Hypotype: GSC 99032; Locality: FT2 (GSC Loc. C-177368); Fannin Formation, Kunae Zone.
4a,b. Hypotype: GSC 98673; Locality: DT1 (GSC Loc. O-48564); Fannin Formation, Kunae Zone.
7a-c. Hypotype: GSC 98675 (b = latex cast); Locality: DT1 (GSC Loc. O-48564); Fannin Formation, Kunae Zone.
8. Hypotype: GSC 98674; Locality: DT1 (GSC Loc. O-48564); Fannin Formation, Kunae Zone.

EXPLANATION OF PLATE 13

All figures are natural size.

Figure — Page

1–4. *Pseudoskirroceras imlayi* Smith and Tipper, 1988. 41

1. Holotype: GSC 87783 (latex cast); Locality: I08 (GSC Loc. C-90977); Ghost Creek Formation, Imlayi Zone.
2. Paratype: GSC 87785; Locality: I08 (GSC Loc. C-81733); Ghost Creek Formation, Imlayi Zone.
3. Hypotype: GSC 98678; Locality: I09 (GSC Loc. C-81707); Ghost Creek Formation, Imlayi Zone.
4. Paratype: GSC 87784; Locality: I08 (GSC Loc. C-81733); Ghost Creek Formation, Imlayi Zone.

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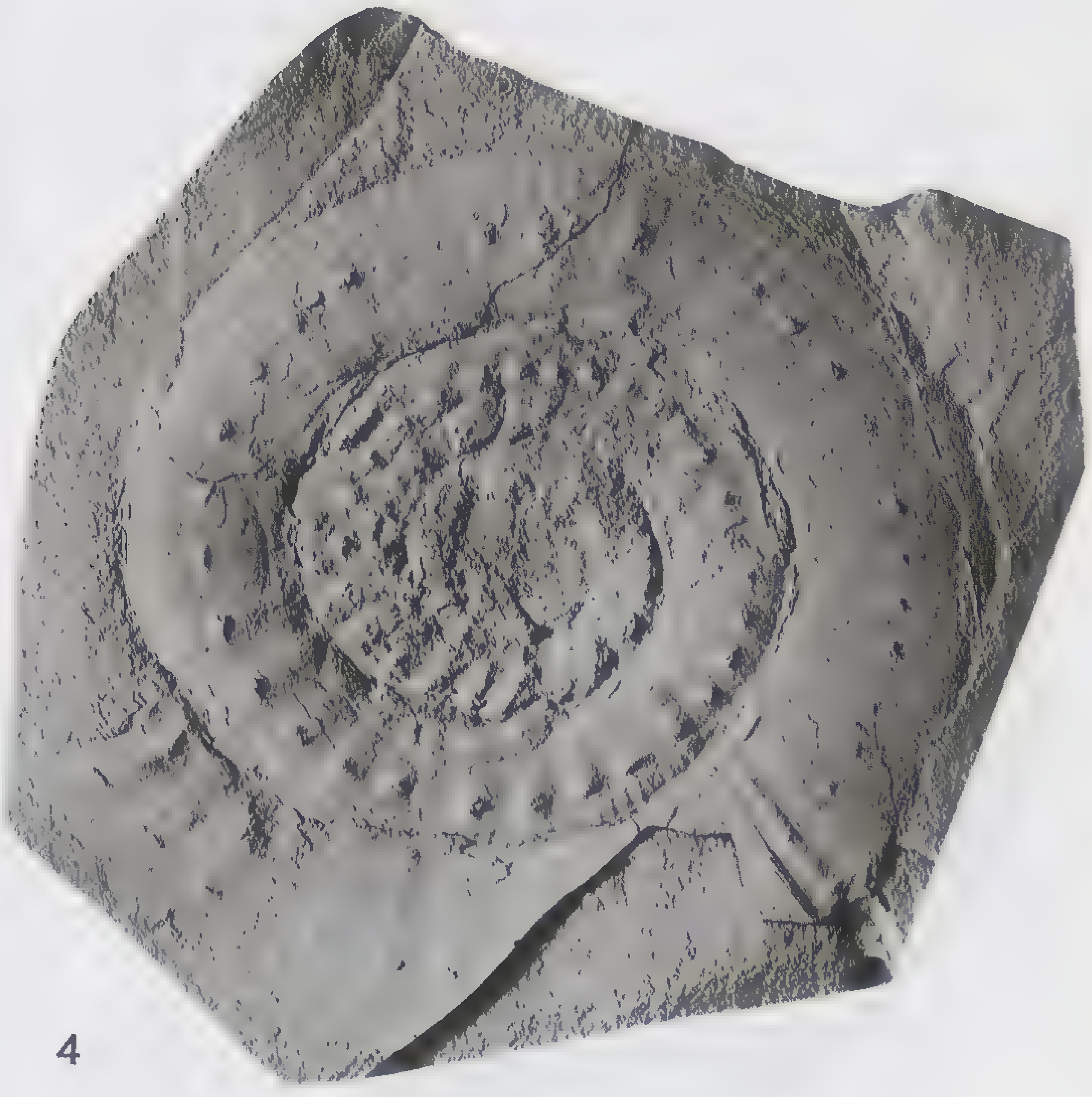

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EXPLANATION OF PLATE 14

All figures are natural size.

Figure Page

1–4. *Pseudoskirroceras imlayi* Smith and Tipper, 1988. 41

1. Hypotype: GSC 95572; Locality: I08 (GSC Loc. C-157551); Ghost Creek Formation, Imlayi Zone.
2. Hypotype: GSC 98737; Locality: I08 (GSC Loc. C-157551); Ghost Creek Formation, Imlayi Zone.
3. Hypotype: GSC 98700 (latex cast); Locality: I08 (GSC Loc. C-157551); Ghost Creek Formation, Imlayi Zone.
4. Hypotype: GSC 98715 (latex cast); Locality: I08 (GSC Loc. C-157551); Ghost Creek Formation, Imlayi Zone.

EXPLANATION OF PLATE 15

All figures are natural size.

Figure		Page
1.	*Pseudoskirroceras imlayi* Smith and Tipper, 1988.	41
	Hypotype: GSC 98680; Locality: I08 (GSC Loc. C-90977); Ghost Creek Formation, Imlayi Zone.	
2.	*Phricodoceras* cf. *taylori* (J. de C. Sowerby, 1826).	41
	Specimen: GSC 87789 (latex cast); Locality: I08 (GSC Loc. C-90974); Ghost Creek Formation, Imlayi Zone.	
3,4.	*Dubariceras silviesi* (Hertlein, 1925).	43
	3. Hypotype: GSC 87792; Locality: GT3 (GSC Loc. C-81712); Rennell Junction Member.	
	4. Hypotype: GSC 98683; Locality: I02 (GSC Loc. O-93721); Rennell Junction Member, Whiteavesi Zone.	

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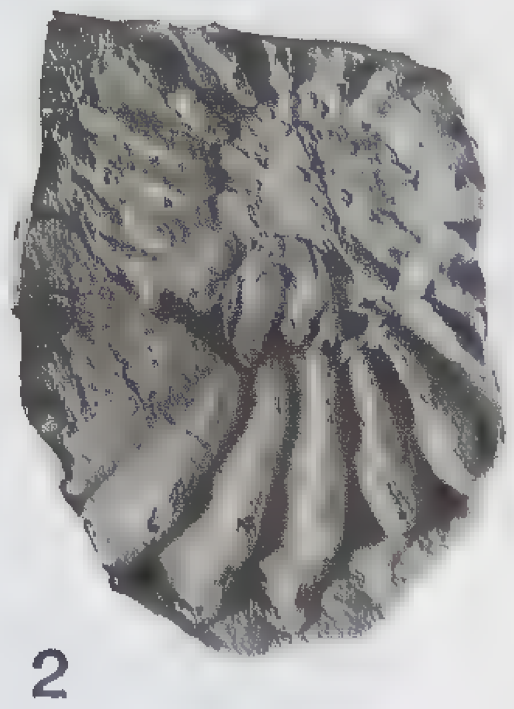

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EXPLANATION OF PLATE 16

All figures are natural size. The last suture is marked by an arrowhead.

Figure	Page

1,2. *Dubariceras freboldi* Dommergues, Mouterde, and Rivas, 1984. 42

1. Hypotype: GSC 87794 (latex cast); Locality: GT3 (GSC Loc. C-90587); Rennell Junction Member, Freboldi Zone.

2a,b. Hypotype: GSC 98686; Locality: E48 (GSC Loc. C-90554); Rennell Junction Member, Freboldi Zone.

3–5,7. *Metaderoceras evolutum* (Fucini, 1921). 44

3a,b. Hypotype: GSC 95576; Locality: E27 (GSC Loc. O-91794); Rennell Junction Member, Whiteavesi Zone.

4. Hypotype: GSC 98688 (latex cast); Locality: D03 (GSC Loc. O-93565); Ghost Creek Formation, Whiteavesi Zone.

5a,b. Hypotype: GSC 98689; Locality: ET1 (GSC Loc. O-48603).

7. Hypotype: GSC 98691 (latex cast); Locality: D03 (GSC Loc. O-93565); Ghost Creek Formation, Whiteavesi Zone.

6. *Metaderoceras*? aff. *mouterdei* (Frebold, 1970). 45

6a,b. Specimen: GSC 87797; Locality: C03 (GSC Loc. C-80610); Fannin Formation, Freboldi Zone.

EXPLANATION OF PLATE 17

All figures are natural size. The last suture is marked by an arrowhead.

Figure		Page
1.	*Metaderoceras* sp.	46
	Specimen: GSC 98702; Locality: BT1 (GSC Loc. C-117025); Ghost Creek Formation, Imlayi Zone.	
2,3.	*Metaderoceras talkeetnaense* Thomson and Smith, 1992.	45
	2a,b. Hypotype: GSC 98703; Locality: E38 (GSC Loc. C-80348); Rennell Junction Member, Whiteavesi Zone.	
	3. Hypotype: GSC 98704; Locality: GT1 (GSC Loc. C-90579); Rennell Junction Member, Whiteavesi Zone.	
4,5.	*Reynesoceras colubriforme* (Bettoni, 1900).	46
	4a,b. Hypotype: GSC 87796; Locality: E57 (GSC Loc. C-90614); Fannin Formation, Kunae Zone.	
	5a,b. Hypotype: GSC 98706; Locality: E57 (GSC Loc. C-90614); Fannin Formation, Kunae Zone.	

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EXPLANATION OF PLATE 18

All figures are natural size. The last suture is marked by an arrowhead.

Figure — Page

1. *Metaderoceras evolutum* (Fucini, 1921). 44
   Hypotype: GSC 98707 (latex cast); Locality: D07 (GSC Loc. C-80249); Ghost Creek Formation, Whiteavesi Zone.
2. *Reynesoceras* aff. *colubriforme* (Bettoni, 1900). 46
   2a,b. Specimen: GSC 98708; Locality: E57 (GSC Loc. C-90614); Fannin Formation, Kunae Zone.
3. *Reynesoceras italicum* (Fucini, 1901). 47
   Hypotype: GSC 98712 (latex cast); Locality: I05 (GSC Loc. O-93723); Fannin Formation, Kunae Zone.
4. *Reynesoceras*? sp. 48
   Specimen: GSC 98709 (latex cast); Locality: ET4 (GSC Loc. O-93579); Fannin Formation, Kunae Zone.
5. *Reynesoceras* sp. 48
   5a,b. Specimen: GSC 98672; Locality: E57 (GSC Loc. C-90614); Fannin Formation, Kunae Zone.

6,7. *Reynesoceras ragazzonii* (Hauer, 1861). 47
   6a,b. Hypotype: GSC 87800; Locality: DT1 (GSC Loc. O-48564); Fannin Formation, Kunae Zone.
   7a,b. Hypotype: GSC 98714; Locality: I06 (GSC Loc. C-90542); Fannin Formation, Kunae Zone.

EXPLANATION OF PLATE 19

All figures are natural size. The last suture is marked by an arrowhead.

Figure	Page
1. *Amaltheus stokesi* (J. Sowerby, 1818).	51
1a,b. Hypotype: GSC 98711; Locality: FT2 (GSC Loc. C-56954); Fannin Formation, Kunae Zone.	
2. *Liparoceras* (*Becheiceras*) *bechei* (J. de C. Sowerby, 1821).	52
2a,b. Hypotype: GSC 99033; Locality: FT2 (GSC Loc. C-177368); Fannin Formation, Kunae Zone.	
3. *Metaderoceras mouterdei* (Frebold, 1970).	44
3a,b. Holotype: GSC 20337; Locality: ET1 (GSC Loc. O-48603).	
4. *Metaderoceras*? aff. *mouterdei* (Frebold, 1970).	45
4a,b. Specimen: GSC 98692; Locality: C03 (GSC Loc. C-117027); Fannin Formation, Freboldi Zone.	

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EXPLANATION OF PLATE 20

All figures are natural size. The last suture is marked by an arrowhead.

Figure Page

1. *Liparoceras* (*Becheiceras*) *bechei* (J. Sowerby, 1821). 52
   1a,b. Hypotype: GSC 78715; Locality: E32 (GSC Loc. O-91807); Rennell Junction Member, Whiteavesi Zone.
2. *Amaltheus viligaensis* (Tuchkov, 1954). 51
   2a-c. Hypotype: GSC 87805; Locality: E62 (GSC Loc. C-81716); Fannin Formation, Carlottense Zone.
3. *Amaltheus stokesi* (J. Sowerby, 1818). 51
   3a,b. Hypotype: GSC 98717; Locality: GT4 (GSC Loc. C-81927); Fannin Formation, Kunae Zone.
4. *Arieticeras* aff. *domarense* (Meneghini, 1867). 55
   4a,b. Specimen: GSC 98718; Locality: ET5 (GSC Loc. C-117002); Fannin Formation, Carlottense Zone.
5. *Arieticeras disputabile* (Fucini, 1908). 54
   5a,b. Hypotype: GSC 98719; Locality: GT4 (GSC Loc. C-81927); Fannin Formation, Kunae Zone.

6,7. *Arieticeras lupheri* Imlay, 1968. 55
   6a,b. Hypotype: GSC 98720; Locality: I06 (GSC Loc. C-90542); Fannin Formation, Kunae Zone.
   7a,b. Hypotype: GSC 98721; Locality: I06 (GSC Loc. C-90542); Fannin Formation, Kunae Zone.

8. *Arieticeras* cf. *micrasterias* (Meneghini, 1874). 56
   Specimen: GSC 98722 (latex cast); Locality: I17 (GSC Loc. C-81703); Fannin Formation, Kunae Zone.

9,10. *Arieticeras* cf. *ruthenense* (Reynès, 1868). 56
   9a,b. Specimen: GSC 98723; Locality: I06 (GSC Loc. C-90542); Fannin Formation, Kunae Zone.
   10a,b. Specimen: GSC 98724 (b = latex cast); Locality: I14 (GSC Loc. C-81730); Fannin Formation, Kunae Zone.

11,12. *Arieticeras* aff. *algovianum* (Oppel, 1862). 54
   11. Specimen: GSC 98725; Locality: I17 (GSC Loc. C-81703); Fannin Formation, Kunae Zone.
   12. Specimen: GSC 98726 (latex cast); Locality: I17 (GSC Loc. C-81703); Fannin Formation, Kunae Zone.

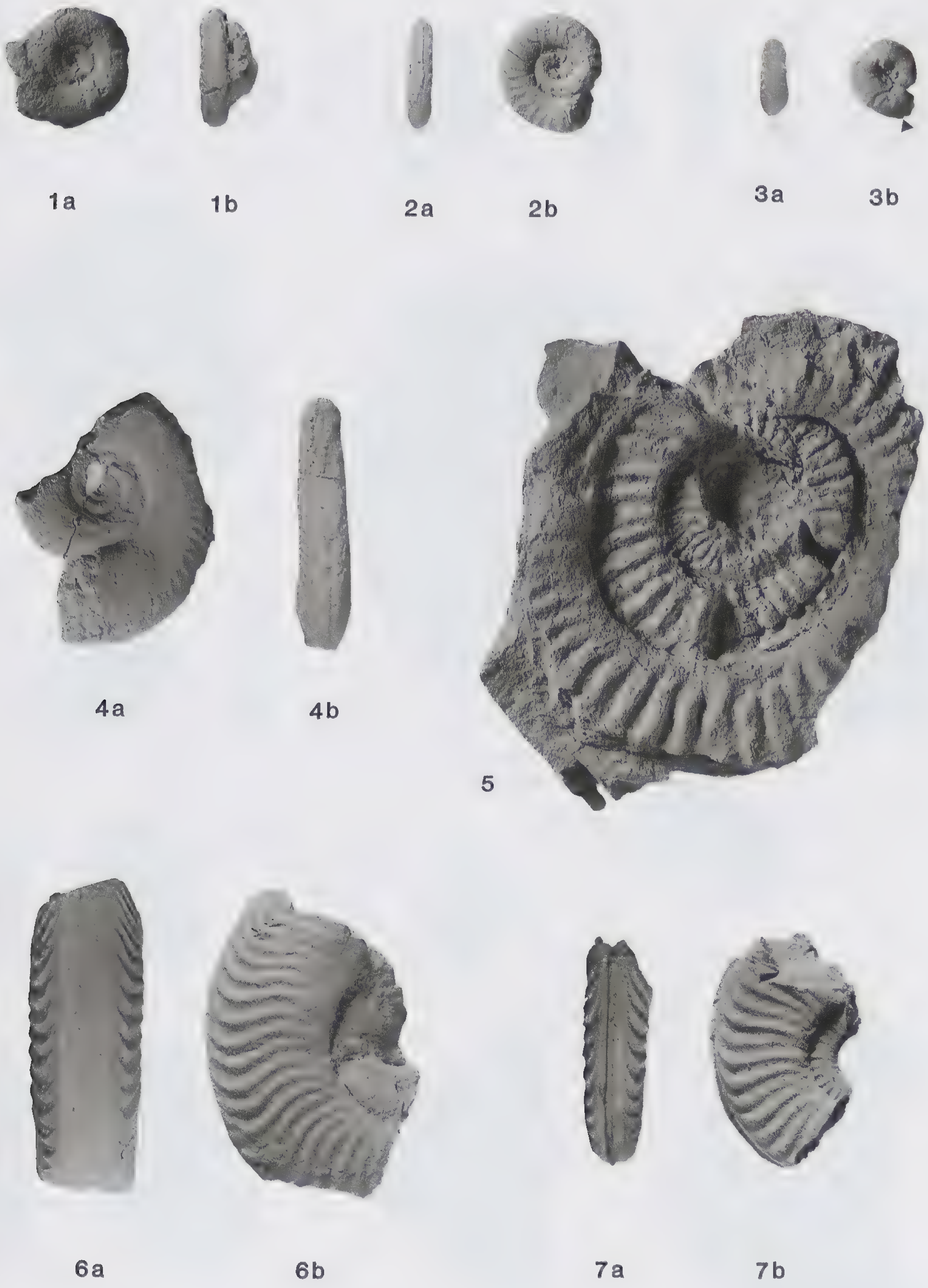
13. *Oregonites*? *dawsoni*, new species. 59
   Holotype: GSC 98727; Locality: E63 (GSC Loc. O-93750); Fannin Formation, Carlottense Zone.

14. *Fieldingiceras fieldingii* (Reynès, 1868). 60
   14a,b. Hypotype: GSC 98728; Locality: ET5 (GSC Loc. C-117031); Fannin Formation, Carlottense Zone.

EXPLANATION OF PLATE 21

All figures are natural size. The last suture is marked by an arrowhead.

Figure		Page
1,4.	*Fieldingiceras pseudofieldingii* (Fucini, 1904).	60
	1a,b. Hypotype: GSC 99025; Locality: I07 (GSC Loc. C-177355); Fannin Formation, Kunae Zone.	
	4a,b. Hypotype: GSC 99036; Locality: FT2 (GSC Loc. C-177368); Fannin Formation, Kunae Zone.	
2.	*Arieticeras disputabile* (Fucini, 1908).	54
	2a,b. Hypotype: GSC 99037; Locality: FT2 (GSC Loc. C-177368); Fannin Formation, Kunae Zone.	
3.	*Fieldingiceras fieldingii* (Reynès, 1868).	60
	3a,b. Hypotype: GSC 99040; Locality: ET5 (GSC Loc. C-80833); Fannin Formation, Carlottense Zone.	
5.	*Canavaria*? sp.	59
	Specimen: GSC 98698; Locality: E61 (GSC Loc. C-80825); Fannin Formation, Carlottense Zone.	
6,7.	*Fuciniceras* sp.	63
	6a,b. Specimen: GSC 99035; Locality: FT2 (GSC Loc. C-177368); Fannin Formation, Kunae Zone.	
	7a,b. Specimen: GSC 99034; Locality: FT2 (GSC Loc. C-177368); Fannin Formation, Kunae Zone.	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EXPLANATION OF PLATE 22

All figures are natural size.

Figure — Page

1,2. *Fontanelliceras* sp. 58
1a,b. Specimen: GSC 98583; Locality: E52 (GSC Loc. C-90553); Fannin Formation, Kunae Zone.
2a,b. Specimen: GSC 98584; Locality: D22 (GSC Loc. C-80768); Fannin Formation, Kunae Zone.

3–5. *Fieldingiceras pseudofieldingii* (Fucini, 1904). 60
3. Hypotype: GSC 98587; Locality: I06 (GSC Loc. C-90542); Fannin Formation, Kunae Zone.
4a,b. Hypotype: GSC 98590; Locality: D20 (GSC Loc. C-80765); Fannin Formation, Kunae Zone.
5a,b. Hypotype: GSC 98591; Locality: I06 (GSC Loc. C-90542); Fannin Formation, Kunae Zone.

6,8–9. *Leptaleoceras* aff. *accuratum* (Fucini, 1931). 57
6. Specimen: GSC 95577 (latex cast); Locality: I17 (GSC Loc. C-81703); Fannin Formation, Kunae Zone.
8. Specimen: GSC 98593; Locality: I17 (GSC Loc. C-81703); Fannin Formation, Kunae Zone.
9. Specimen: GSC 98599 (latex cast); Locality: I17 (GSC Loc. C-81703); Fannin Formation, Kunae Zone.

10. *Leptaleoceras compressum* (Monestier, 1934). 57
10a,b. Hypotype: GSC 98601; Locality: I06 (GSC Loc. C-90542); Fannin Formation, Kunae Zone.

7,11–13. *Leptaleoceras* sp. 58
7a,b. Specimen: GSC 98592; Locality: FT2 (GSC Loc. C-177368); Fannin Formation, Kunae Zone.
11. Specimen: GSC 98605; Locality: I06 (GSC Loc. C-90542); Fannin Formation, Kunae Zone.
12a,b. Specimen: GSC 98602; Locality: I06 (GSC Loc. C-90542); Fannin Formation, Kunae Zone.
13a,b. Specimen: GSC 98604; Locality: I06 (GSC Loc. C-90542); Fannin Formation, Kunae Zone.

14,15. *Fuciniceras* cf. *targionii* Fucini, 1905. 61
14. Specimen: GSC 98606; Locality: I17 (GSC Loc. C-81703); Fannin Formation, Kunae Zone.
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All figures are natural size. The last suture is marked by an arrowhead.

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	3a,b. Specimen: GSC 99016; Locality: E62 (GSC Loc. C-81716); Fannin Formation, Carlottense Zone.	
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	5a,b. Specimen: GSC 98743; Locality: I06 (GSC Loc. C-90542); Fannin Formation, Kunae Zone.	
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	7a,b. Specimen: GSC 98742; Locality: D20 (GSC Loc. C-80765); Fannin Formation, Kunae Zone.	

1a
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2a
2b
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4
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5b
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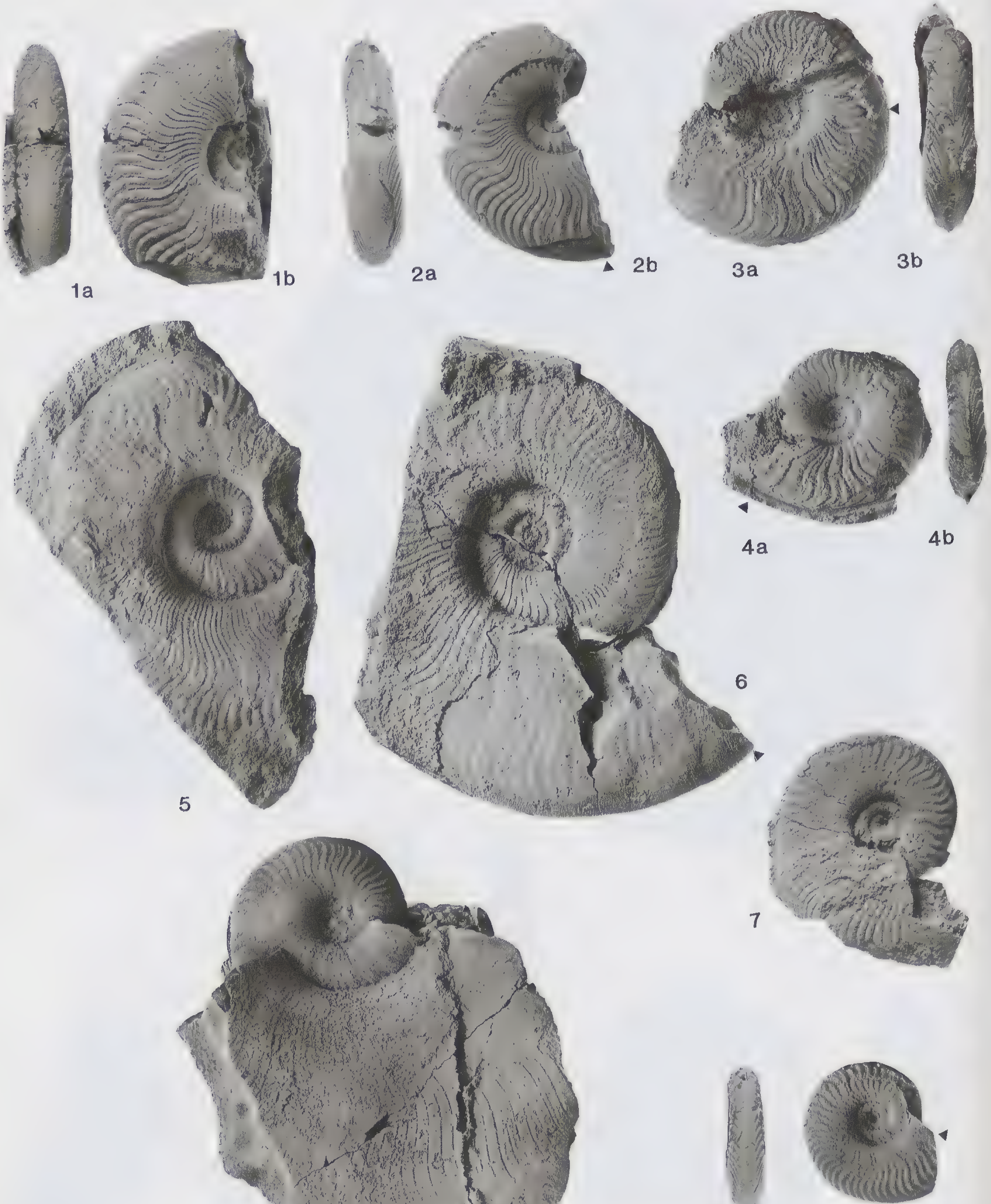
6b
7a
7b


1a
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4b
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9b

EXPLANATION OF PLATE 24

All figures are natural size. The last suture is marked by an arrowhead.

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	3a,b. Specimen: GSC 98697; Locality: ET5 (GSC Loc. C-117003); Fannin Formation, Carlottense Zone.	
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	5. Hypotype: GSC 98733; Locality: D24 (GSC Loc. O-93754); Fannin Formation, Carlottense Zone.	
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	8. Hypotype: GSC 98649; Locality: E63 (GSC Loc. C-90545); Fannin Formation, Carlottense Zone.	
	9a,b. Hypotype: GSC 98735; Locality: ET5 (GSC Loc. C-117031); Fannin Formation, Carlottense Zone.	

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All figures are natural size. The last suture is marked by an arrowhead.

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1–3.	*Protogrammoceras (Protogrammoceras) skidegatense,* new species.	66
1.	Paratype: GSC 98741; Locality: E63 (GSC Loc. C-90545); Fannin Formation, Carlottense Zone.	
2a,b.	Holotype: GSC 98740; Locality: D25 (GSC Loc. C-80772); Fannin Formation, Carlottense Zone.	
3.	Paratype: GSC 98739; Locality: D24 (GSC Loc. C-0–93574); Fannin Formation, Carlottense Zone.	

1
2a
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3

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2a
2b
3a
3b
4a
4b
4c
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5b
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6b
7a
7b
8a
8b
9
10
11

EXPLANATION OF PLATE 26

All figures are natural size. The last suture is marked by an arrowhead.

Figure		Page
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	Holotype: GSC 9052; Locality: DT2 (GSC Loc. O-13630); Fannin Formation, Carlottense Zone or Lower Toarcian.	
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	5a,b. Hypotype: GSC 98641; Locality: E67 (GSC Loc. C-807853); Fannin Formation, Carlottense Zone.	
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	9. Holotype: GSC 9053; Locality: DT2 (GSC Loc. C-117033); Fannin Formation, Carlottense Zone or Lower Toarcian.	
	10. Hypotype: GSC 98736; Locality: E65 (GSC Loc. O-91835); Fannin Formation, Carlottense Zone.	
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EXPLANATION OF PLATE 27

All figures are natural size. The last suture is marked by an arrowhead.

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1a,b. Specimen: GSC 98677; Locality: ET5 (GSC Loc. C-117002); Fannin Formation, Carlottense Zone.
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3a,b. Hypotype: GSC 98611; Locality: E65 (GSC Loc. C-80783); Fannin Formation, Carlottense Zone.
4. Hypotype: GSC 99045; Locality: ET5 (GSC Loc. C-117003); Fannin Formation, Carlottense Zone.
5a,b. Hypotype: GSC 98634; Locality: E67 (GSC Loc. C-80785); Fannin Formation, Carlottense Zone.
6a,b. Hypotype: GSC 98640; Locality: E65 (GSC Loc. O-91835); Fannin Formation, Carlottense Zone.
7a-c. Hypotype: GSC 98732; Locality: D24 (GSC Loc. O-93574); Fannin Formation, Carlottense Zone.

1a
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6a
6b
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7b
7c

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4a
4b
5a
5b
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7a
7b
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9a
9b
10a
10b
11a
11b

EXPLANATION OF PLATE 28

All figures are natural size. The last suture is marked by an arrowhead.

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1–11. *Lioceratoides* (*Pacificeras*) *propinquum* (Whiteaves, 1884). 71

1a,b. Hypotype: GSC 98681; Locality: E63 (GSC Loc. C-90545); Fannin Formation, Carlottense Zone.

2a,b. Lectotype: GSC 4877; Locality: DT2 (GSC Loc. C-117033); Fannin Formation, Carlottense Zone or Lower Toarcian.

3. Hypotype: GSC 98682; Locality: E63 (GSC Loc. C-90545); Fannin Formation, Carlottense Zone.

4a,b. Hypotype: GSC 98685; Locality: ET5 (GSC Loc. C-80824); Fannin Formation, Carlottense Zone.

5a,b. Hypotype: GSC 87804; Locality: ET5 (GSC Loc. C-117003); Fannin Formation, Carlottense Zone.

6a,b. Hypotype: GSC 98687; Locality: E62 (GSC Loc. C-81716); Fannin Formation, Carlottense Zone.

7a,b. Plesiotype of McLearn (1932): GSC 6491; Locality: DT2 (GSC Loc. C-117033); Fannin Formation, Carlottense Zone or Lower Toarcian.

8. Hypotype: GSC 98661 (latex cast); Locality: E67 (GSC Loc. C-80785); Fannin Formation, Carlottense Zone.

9a,b. Hypotype: GSC 98655; Locality: E67 (GSC Loc. C-80785); Fannin Formation, Carlottense Zone.

10a,b. Hypotype: GSC 98676; Locality: ET5 (GSC Loc. C-117003); Fannin Formation, Carlottense Zone.

11a,b. Hypotype: GSC 87806; Locality: ET5 (GSC Loc. C-117003); Fannin Formation, Carlottense Zone.

EXPLANATION OF PLATE 29

Figure is natural size.

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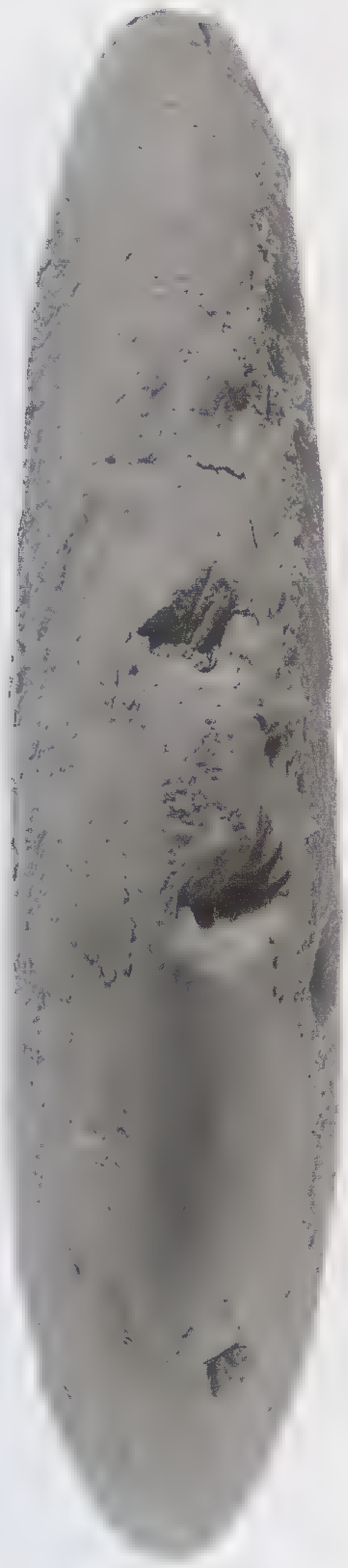
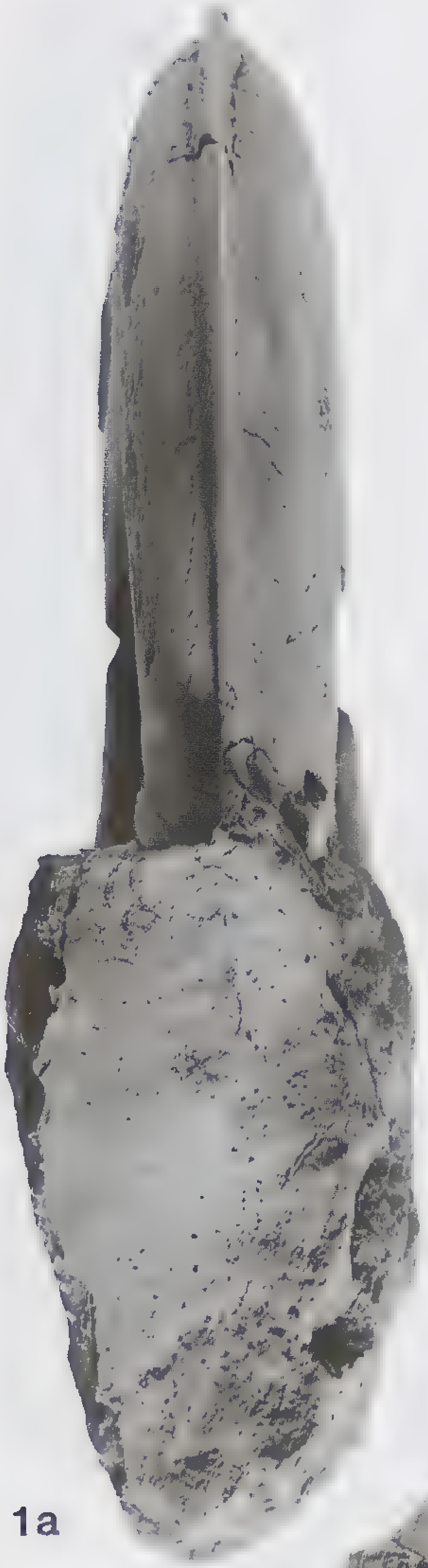
1. *Lioceratoides* (*Pacificeras*) *propinquum* (Whiteaves, 1884). 71
   1a,b. Plesiotype of McLearn (1932): GSC 6490; Locality: DT2 (GSC Loc. C-117033); Fannin Formation, Carlottense Zone or Lower Toarcian.

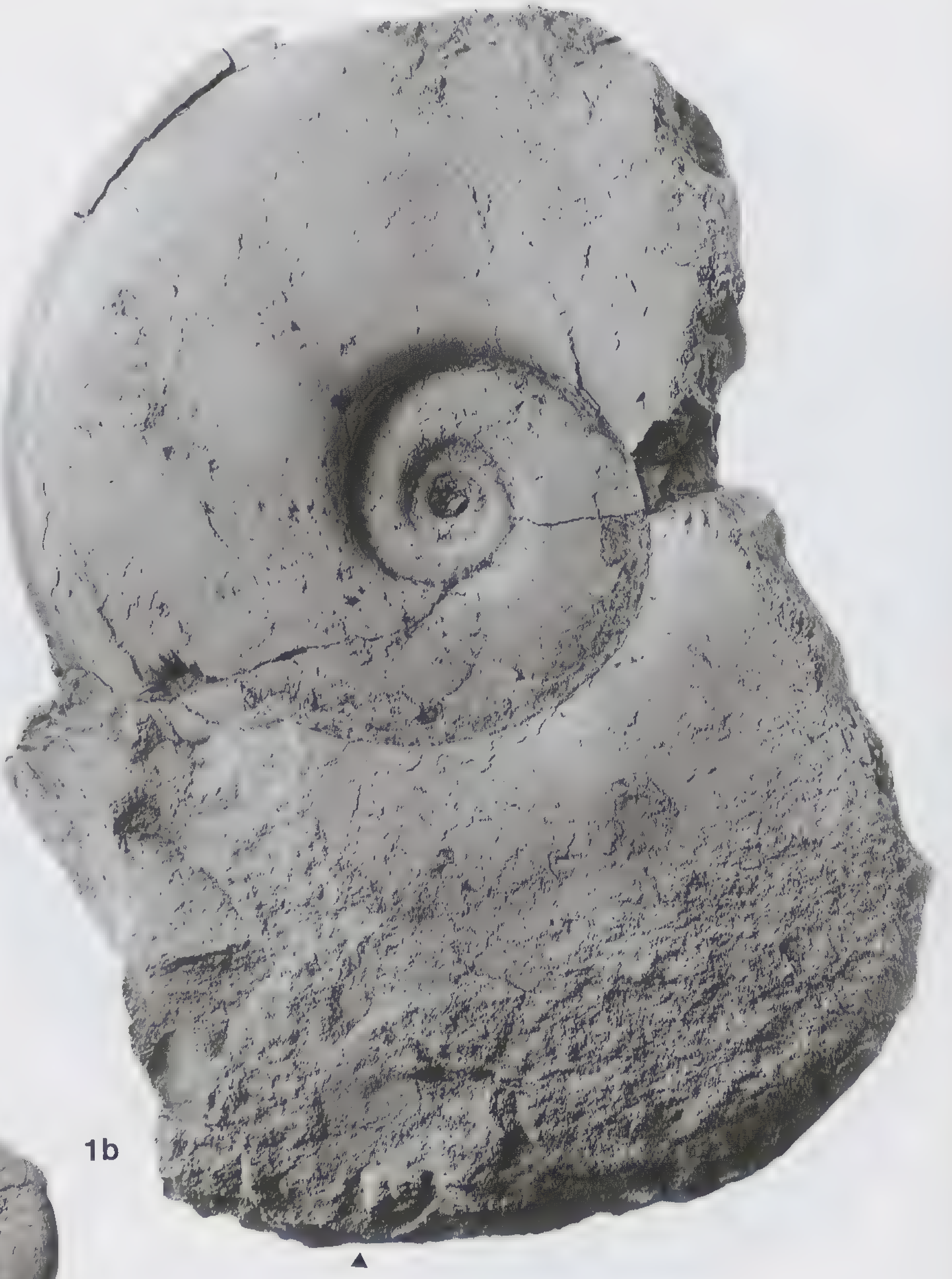
1a



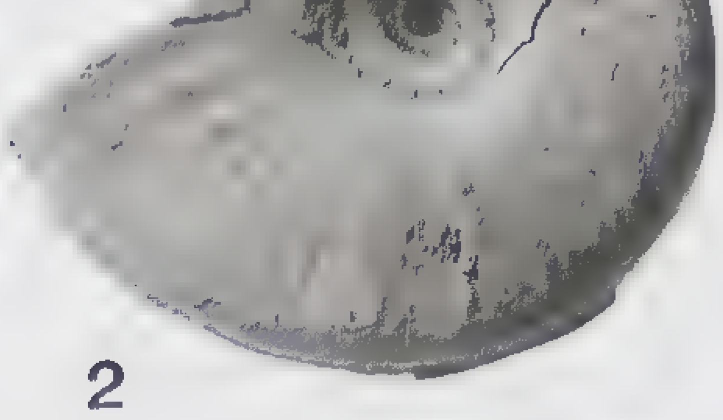
1b



1a

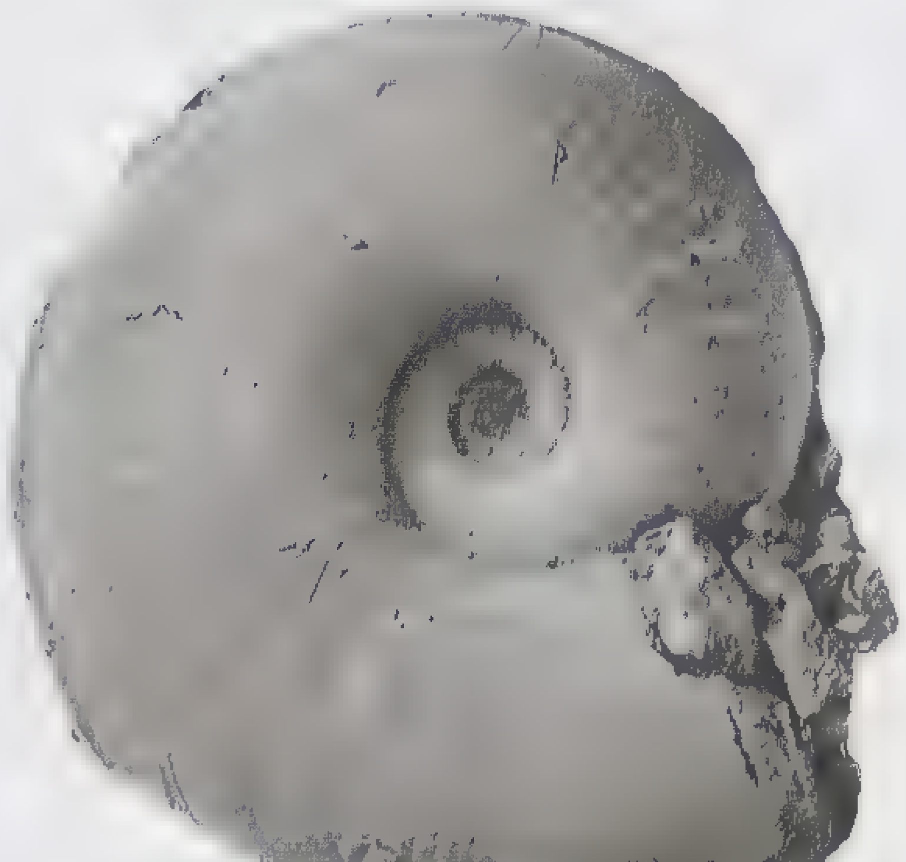


1b



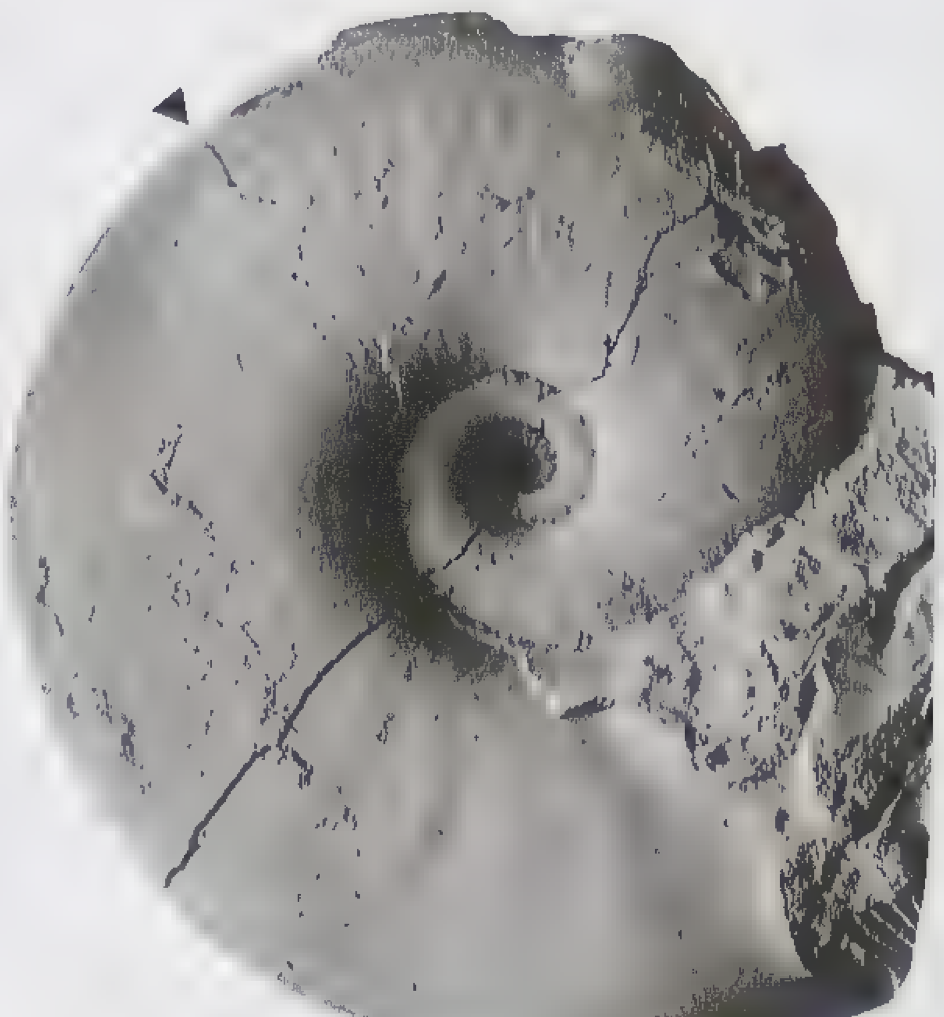
2

3a



3b

4a



4b

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All figures are natural size. The last suture is marked by an arrowhead.

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1–4. *Tiltoniceras antiquum* (Wright, 1882). 72

1a,b. Hypotype: GSC 98728; Locality: E62 (GSC Loc. C-81716); Fannin Formation, Carlottense Zone.

2. Hypotype: GSC 98713; Locality E65 (GSC Loc. C-90544); Fannin Formation, Carlottense Zone.

3a,b. Hypotype: GSC 98730; Locality: ET5 (GSC Loc. C-117002); Fannin Formation, Carlottense Zone.

4a,b. Hypotype: GSC 98731; Locality: ET5 (GSC Loc. C-117003); Fannin Formation, Carlottense Zone.

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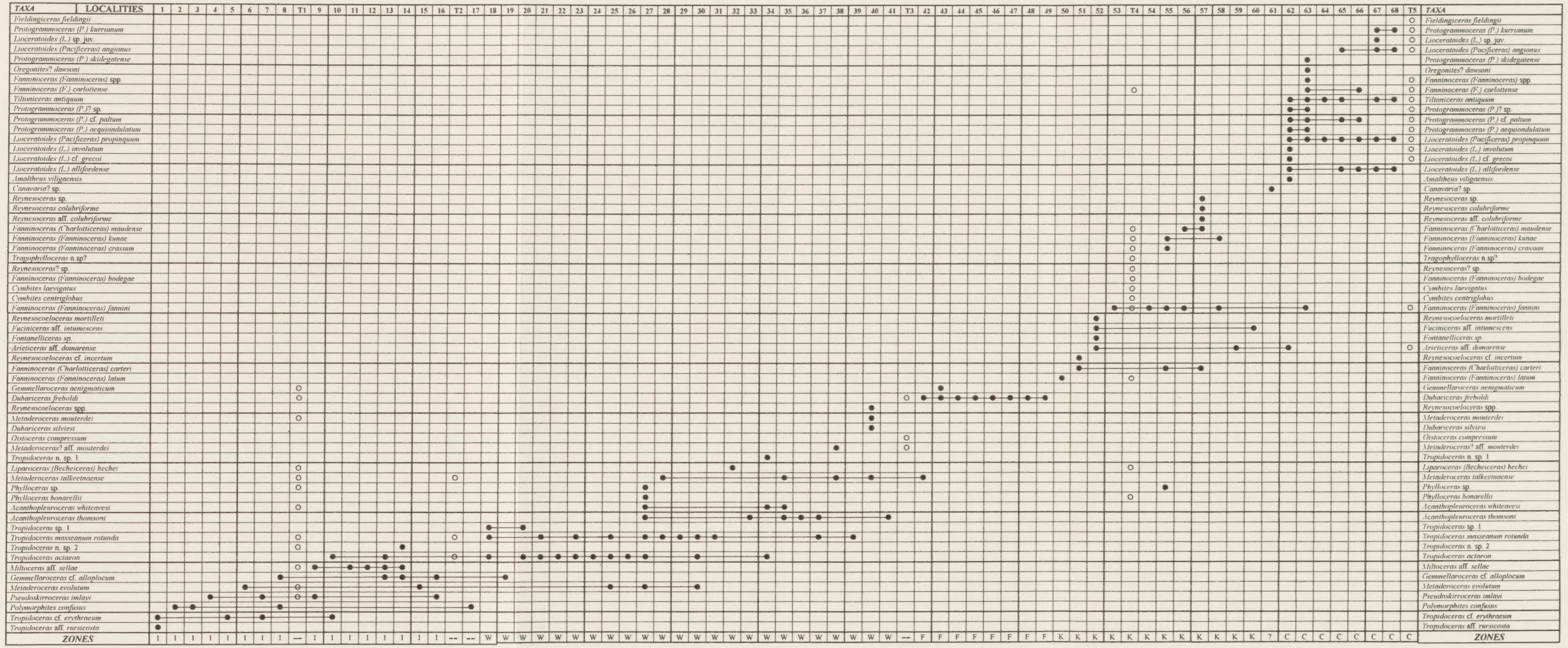

Text-figure 20.—The ammonite fauna and biostratigraphy of section E. See Text-figure 11 for stratigraphic details and Text-figure 6 for the legend.

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